THE

ELECTRICAL REVIEW.

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THE

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THE FUTURE SUPREMACY IN THE IRON MARKET.

VERY *apropos* is Mr. J. S. Jeans's contribution to the *Engineering Magazine*, which deals with American competition in iron manufacture. Mr. Jeans sees plainly that American competition is likely to increase, and he points out that the keenest competition comes from Pittsburgh, which is over 400 miles inland. To enable some idea to be formed as to the future prospects of European and American ironworks, we are invited to consider the essential elements of success in manufacturing. These are thus classified:—

Abundance of raw materials of good quality.

Favourable manufacturing conditions near shipping ports.

Cheap transport, especially by land.

Economical—not necessarily cheap—labour.

Efficient equipment.

Ready and economical distribution.

America has certain conditions unapproached by Great Britain in an abundance of cheap high-class ores. The Lake Superior region is the source of the largest supplies of high-class ores in the world. They are most easily mined, and their only drawback is distance from suitable fuel. Pittsburgh, at the junction of two rivers and upon the fuel, was thus selected as a suitable site for manufacturing. At the same time Chicago, though nearly 500 miles from both ore and fuel, was also selected because it was so good a centre of distribution, and, like Pittsburgh, a place of population. Philadelphia also became an iron manufacturing locality because it had population, fuel, and shipping; while Alabama had a try because, though not a convenient centre of population or distribution, it had ore and fuel at hand. Cleveland, on Lake Erie, seems destined to be a fifth centre of iron manufacture. The most important of the above groups depend on Lake Superior ores, which have furnished 60 to 65 per cent. ore, costing, with 40 to 150 miles of railway carriage and 500 to 850 miles of water carriage, only some 12s. 6d. to 21s. per ton; the lower figure being lower than any cost in Great Britain. The Alabama ores are about 40 per cent. stuff, and cost 2s. 6d. to 4s. 6d. per ton at the furnace, and so are cheaper than the low grade ores of our own Cleveland district, or of those of Luxembourg and Lorraine. American labour cost, though wages are nominally high, is less per ton of product than European; and Mr. Jeans explains this in two terms; machinery and Trades' Unions.

The American workmen, in fact, do not object to

machinery, and, therefore, it has been more largely employed, with the result that English trade will either go to the wall or the ignorant men who oppose machinery will have to give in. The Carnegie Company have always been very firm in their dealings with their workmen, and appear to have been able to adjust things for three years at a time upon a sliding scale which is fixed after a workmen's committee has been allowed to investigate the firm's books as to contracts pending, net price received for manufactures, &c. The company have had one strike only, which was much on the scale of civil war, or rather uncivil war, for we read of shootings and poisonings taking place. This was in 1892, the result being that non-union labour has since been largely employed. In the way of equipment America has quite taken a leading place, but Mr. Jeans thinks England is coming forward again in this respect. Great Britain, too, ought to be unrivalled in shipping facilities, though high railway rates have deprived her of part of this advantage. Recent developments of ore in the Lake Superior district will further assist American production, and as American railway rates are but one-third of ours, the cost of carriage is not so very great after all, and steel rails have been sold in Pittsburgh at gradually lessening prices, until to-day they are at or below $17, say £3 10s. per ton. In the face of this, is it not strange that the American monopolists generally should still cry out for high tariffs. It is certain that the facts given in Mr. Jeans's article are worth the study of all of us, and especially of our misguided Trades Unionists, who take so very long to learn the lesson.

Dust Destructors Without Dust.

THE advantage of a dust destructor is that if the supply of dust fails it is easy to fall back upon coal. There have been numerous correspondents to the REVIEW who have sought to establish the fact that there has been a good deal of falling back upon coal in Shoreditch. The Chairman of the Electricity Committee last week, however, gave the official statement, which is as follows:—"In June, the opening month, before they had got into working order, they burned 39¼ tons of coal; in July, 20 tons; August, 22; September, 30; October, 30; and the present month they had received 30 tons, and burned 21. The cause was that while the slopping was about, the parish received very little dust, and as a result they had to burn coal. They were only burning coal between Saturday night and Sunday morning, when the refuse was exhausted." We must confess our inability to comprehend the complaint that is said to cause the failure of the supply of dust, and it would appear that the introduction of dust destructors into electric lighting will involve an enlargement of the electrical vocabulary, which, considering its present freedom from arbitrary terms, would be a pity. Although the Shoreditch Vestry have attained some success with the use of refuse for steam raising, we cannot help thinking that the official figures are somewhat alarming, and in the interests both of dust destructors and electric lighting some fuller details ought to be given.

Sunday Coal Consumption at Shoreditch.

IN the month of October, 30 tons of coal were consumed, and if we are right in assuming that this consumption is confined to Sundays, we have six tons for each Sabbath Day. The maximum load at the electric lighting works, according to Mr. Kershaw, is 250 units, and as we are informed this is always met by the heat generated from dust, we can fairly affirm that the heaviest load never occurs on Sundays. We have endeavoured to imagine what the consumption of electrical energy would be on these days, and if the 57 street arc lamps burn from 5 o'clock till 12 midnight, the number of B. of T. units required would not exceed 292. After midnight the arcs are replaced by 114 32-C.P. incandescent lamps, and their consumption, from 12 midnight to 5 a.m., would be 68 kw. For private lighting we consider that 3,000 8-C.P burning for five hours would fairly represent the demand, and this would necessitate 480 kw. hrs. Therefore, the total demand on Sundays would probably be

292 kw. for arcs	}	street lighting.	
68 „	incandescent	}	street lighting.
480 „	„	private	„

840 kilowatt hours.

If we take the outside estimate of allowing 7 lbs. of coal per kilowatt hour, we can only account for 5,880 lbs. = 2·6 tons, which leaves 3·4 tons per week accounted for. No doubt Mr. Kershaw by the aid of the actual output figures can easily dispose of the foregoing assumptions, and we trust he will take an early opportunity of doing so.

The Stifling of the Salford system.

THE position attained by the Salford Electricity Works is by no means an enviable one. It has been in existence some two years, yet it still necessitates a considerable annual drain upon the rates. Salford is in parts a thickly populated district, and having regard to the extraordinary success that has attended the neighbouring Manchester Corporation Works, it is a little curious that the Salford system should have been a comparative failure. At the same time it is not difficult to find a reason for the ill-success that has followed the works since their initiation. The Corporation were virtually forced to become suppliers of electrical energy, and as an indication of the grudging spirit in which they entered upon the undertaking they relegated the whole arrangements to the tender mercies of the Gas Committee. Under these circumstances it would have been surprising if the electricity system had had fair play; the Gas Committee looked upon it as a rival, and the late Chairman went so far as to declare "that the electric light was a luxury and that those who used it would have to pay for it as such." Not only were the public practically prohibited from becoming consumers, but the actual working and management of the undertaking was hampered by the anomalous arrangement of making the resident electrical engineer responsible to the gas engineer. We are making no reflections upon the ability of the engineer of the gas department, but it is obvious that his training and predilections absolutely rendered it impossible for him to foster and develop a public electric lighting system. It would appear, however, that a more reasonable spirit now pervades the Salford Corporation, and the Electricity Works have been placed in the hands of a special committee which is endeavouring to lift the undertaking out of the Slough of Despond in which it has hitherto remained. We trust their efforts will be successful; they may rest assured that a vigorous and broad minded policy is the only thing needed to make the electricity undertaking a source of benefit and profit to the district.

THE CAPACITY OF SUBMARINE CABLES.

A letter from Mr. W. J. Murphy in *The Electrician* of November 5th on the measurement of the capacity of long cables, with Mr. Elton Young's very able account of the methods in common use recently published in the same journal, draws attention to this subject. The points at issue are not, we believe, very generally understood, and a short discussion of them may be interesting. The relation between the two methods of proceeding known as Thomson's and Gott's is not stated as clearly as it might be. They both depend on the bridge arrangement shown in fig. 1. The

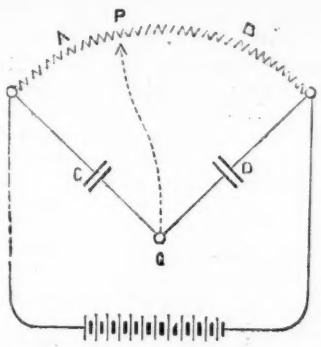


Fig. 1.

comparison between the two condensers depends in each case upon the fact that if $\frac{A}{B} = \frac{D}{C}$, where A, B are the resistances of the two branches of the slides, and C, D the capacities of the two condensers, then the potentials at the points P and Q are the same. The process in each case consists in finding the position P on the slides, which is at the same potential as Q. The difference between the two lies solely in the method of determining whether P and Q are at the same potential. Gott connects P and Q through a galvanometer, and observes the passage or non-passage of a current. Thomson connects P, Q with a wire, and afterwards ascertains whether the condensers have received any charge thereby. The relation upon which both depend, viz., that $\frac{A}{B} = \frac{D}{C}$ when there is no difference of potential between P and Q, does not generally hold when the condensers are imperfectly insulated, or liable to electrification.

If both condensers undergo electrification at the same rate, and if their dielectric resistances are inversely proportional to the capacities the relation holds, and the comparison is perfect. The first condition, viz., that the rates of electrification shall be the same, is not easily secured. The second condition, viz., that the dielectric resistances shall be inversely proportional to the capacities, can be dealt with by arranging an artificial leakage for the known condenser to balance the measured dielectric resistance of the cable. Mr. Murphy's diagram shows this clearly. De Sauty's method is similar to Gott's, the two differing only by the interchange in position of the battery and galvanometer.

Suppose in fig. 2 that E, F are the dielectric resistances of the two condensers. Then, whether Q, R are electrically connected or not, P, Q, R are at the same potential if $\frac{A}{B} = \frac{D}{C} = \frac{E}{F}$, so that if we make the products of the resistances and capacities of the two condensers equal, *i.e.*, $C \times E = D \times F$, both Thomson's and Gott's methods are applicable. Mr. Elton Young notices, however, as a very practical difficulty that leakage resistances of the values required for compensating testing room condensers are not usually available.

But the real difficulty at the back of these and other tests lies in the indefinite character of the quantity that they profess to measure. Mr. Elton Young recognises that the dielectric resistance of a cable or condenser is a definite quantity, independent of the time of application of the testing battery, while the quantity that does vary with the time of application is the capacity: we are glad to see this point explicitly recognised. The capacity of a condenser having a solid dielectric is not a definite quantity any more than the permeability of iron. It may probably be represented by the sum of a constant and an expression depending on the previous history of the dielectric. Of these two parts the constant, if it be one, is considerably the most important, and is the quantity electricians aim at measuring in the usual tests. We are not aware that the relation between the two parts is known at all. All the usual tests proceed on the assumption that the second part is always negligible.

The only satisfactory method of dealing with a quantity of this kind is to measure it continuously as it varies under arranged conditions, as is done in the investigation of an iron

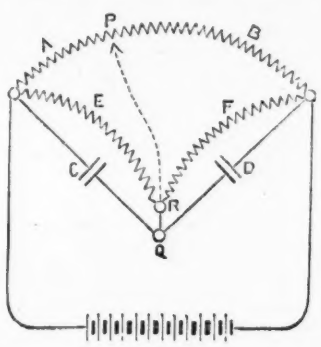


Fig. 2.

magnetic circuit, and we endorse Mr. Elton Young's view that the matter can be best approached by means of the ordinary method of direct deflections with a high resistance in circuit, or as he terms it, the method of slow charge and discharge. Observations of the rate of charging especially in the early stages may throw important light on the behaviour of these solid dielectrics. The use of a guard wire greatly simplifies this sort of work by removing the irregularities due to end leakage.

There is, however, another point of view of this matter. The commercial importance of the capacity of a cable is its action in reducing the size of signals, thereby limiting the speed. If the capacity be calculated from an observation of the reduction in amplitude of an alternating current of known frequency the measure is obtained under precisely the practical conditions that give importance to it. In a long cable earthed at the receiving end the ratio of the amplitudes of the sent and received currents is $\frac{1}{2} e^{\sqrt{\omega K R}}$ where K R are the total capacity and the resistance of the cable stated in C.G.S. units, the frequency of alternation being $\frac{\omega}{\pi}$. A comparison of this kind on a laid cable is a more direct measure of its commercial efficiency than is given by separate measurements of its capacity and conductor resistance.

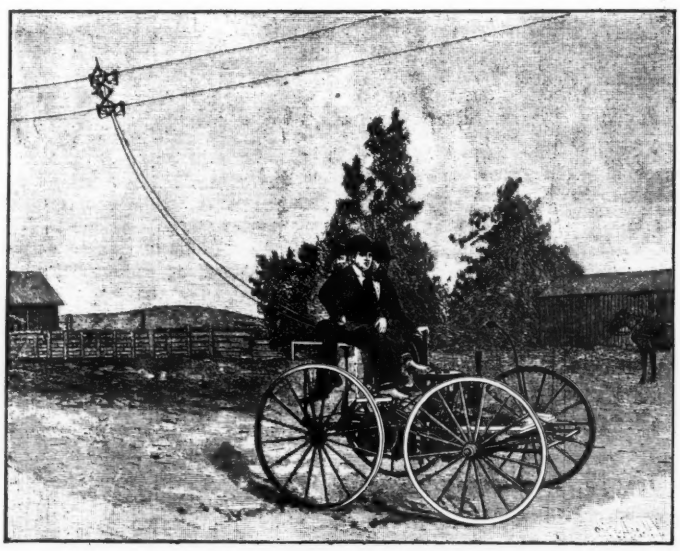
A TROLLEY WAGON FOR COUNTRY ROADS.*

The subject of traction on common roads early received the attention of engineers, and many experiments have been tried to solve this interesting and important problem. The steam traction engine has been used to a limited degree, but it does not appear to have been so successful as it might be. Light auto-mobile carriages have been used to some extent, and it is probable that in the future they will attain a considerable usefulness. The electric carriage offers advantages for use on common roads; but it is doubtful if they will prove very successful, owing to the great weight of the storage batteries, except on the most perfect roads that have small grades. The subject of the transportation of farm produce has engaged the attention of economists, and even of the Government. It is easy to cite statistics which show that the farmers in country districts lose vast sums annually

* *Scientific American.*

owing to the difficulty of transporting their produce to the railroad by which it can be shipped to the consumer, or exported. In England the light railway has been tried with some success, but the expense is against its more general use.

We illustrate a system which is certainly remarkable for its novelty, and which in districts where water power is available, should be very successful. The trolley electrical road wagon shown in our engravings is the invention of Mr. W. G. Caffrey, of Reno, Nevada, who has associated with him Col. H. B. Maxson. The cost of installing the overhead trolley system is not prohibitive, and where a cheap source of power is obtainable, the expense of working and maintenance would not be great. Mr. Caffrey has been at work upon this system for three years, and the wagon which we illustrate has been tested successfully. A line of ordinary poles was set up near the Reno foundry, and the dynamo placed therein. The two wires were secured to the poles about 18 inches apart and 17 feet from the ground, and a trolley with a lazy tongs arrangement allowed the current to be furnished to the wagon. The problem which the inventor had to solve was a difficult one, as a perfect circuit must be maintained at all times, and the contact must be flexible enough to allow a wide divergence from the regular road if necessary.



The improved form of trolley works admirably. It consists of a metallic frame having two overrunning wheels, and underneath these are the two locking wheels, which effectually prevent the top wheels from leaving the wire and still allow the frame to pass the support, holding the wire on the pole. On the lower wire a similar device is used. The two trolleys are connected by an insulated pantograph, or lazy tongs, equipped with suitable guides, thus providing for unequal tension on the trolley wires. The poles are 24 feet long and 6 inches in diameter at the small end. They are placed at intervals of 125 feet. On the inner or road side of these poles are two supports or "pass-bys" of malleable iron. No. 0 bimetallic wires are used. The current is supplied to the wagons by cable which runs on an automatic reel on the wagon, permitting the cable to run out 200 feet if necessary, or wind up to a short length, thus allowing the wagon to follow the ordinary road and permitting it to turn, or do anything required of it. The ordinary trolley pole may also be used, but the cable permits of running the wagon on either side of the ordinary road, allowing it to meet or pass vehicles without difficulty.

The four-wheeled wagon shown in our engraving has wheels 48 inches in diameter. The rear wheels are fastened to a shaft geared to a spring-suspended motor. The motor is a 2 horse-power one of the Westinghouse crane type. In front of the motor a commutator controller is suspended, the handle of which is within easy reach of the person steering the wagon. The front axle is trussed, and the spindles are pivoted to the wheel hub, with an arm extending forward about 18 inches, fastened rigidly to the spindle. These two arms are connected, and the connecting bar again connected to the steering bar. This gives quick turning qualities with easy manipulation. The generator used was a 5 horse-power compound wound Westinghouse 500-volt dynamo. It is said that on the trial trip a speed of 15 miles an hour was reached with a load of 2,500 lbs. on the wheels. The control of both the motor and the steering apparatus was all that was desired. The trolley moved easily over the wires, and there was no difficulty with the "pass bys."

The development of the long distance power transmission, and the utilisation of this or some similar system, will prove of great value to the farmer, and those who have occasion to transport goods along country roads.

MUSCULAR ELECTRICITY.

By J. WRIGHT.

(*Concluded from page* 597.)

These currents were brought to light by Du Bois Reymond, who advanced a theory that all muscles were composed of electromotive particles or molecules, each having a positive centre and negative extremities. This theory bears a close resemblance to that of the construction of a magnet. The following facts, however, quoted by Foster, tend to prove that they are merely artificial or surface currents:—

"1. When a muscle is examined while it still remains untouched as regards its natural tendinous terminations, the currents are much less than when artificial transverse sections have been made; the natural tendinous end is less negative than the cut surface. But the tendinous end becomes at once negative when it is dipped in water or acid, indeed, when it is in any way injured. The less roughly, in fact, a muscle is treated, the less evident are the muscle currents, and it has been maintained that if adequate care be taken to maintain a muscle in an absolutely natural condition, no such currents as those we have been describing exist at all.

"2. Englemann has shown that the surface of the uninjured, inactive ventricle of the frog's heart is iso-electric, *i.e.*, that no current is obtained when the electrodes are placed on any two points of the surface. If, however, any part of the surface be injured, or if the ventricle be cut across so as to expose a cut surface, the injured spot of the cut surface becomes at once most powerfully negative towards the uninjured surface, a strong current being developed which passes through the galvanometer from the uninjured surface to the cut surface or to the injured spot. The negativity thus developed in a cut surface passes off in the course of some hours, but may be restored by making a fresh cut and exposing a fresh surface."

From the divided opinions anent these currents, they have been appropriately termed "currents of rest."

For obtaining accurate results in measurements of such extremely low E.M.Fs. as are occasionally met with in this form of research, the instrument known as Lippmann's capillary electrometer is employed. It consists (fig. 16) of an adjustable mercury arrangement not shown in the fig. the connecting tube of this device communicates with the essential portion of the apparatus at A. B is a closed tube containing a 10 per cent. solution of sulphuric acid, C. Connection with the latter is made by a platinum wire fused through the lower end of the tube. The fine extremity of a capillary tube (bore 20 to 30 μ). D is immersed in the sul-

phuric acid solution, the upper wide extremity containing mercury, with which the second wire of the apparatus is connected. The extremity of the capillary tube is placed under a microscope, the surface of the mercury being brought into the field of vision by adjustment of the mercury pressure apparatus. Any slight variation in the E.M.F. between the two connecting wires is shown by an alteration in the level of the mercury in the capillary tube. It is capable of recording a current as delicate as $\frac{1}{40000}$th volt. It also has many advantages, among which may be mentioned instantaneous indication, dead-beat, and immaterial resistance.

I have already described the method of recording the time taken in a muscular contraction by means of a vibrating

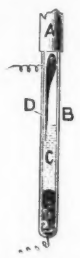


Fig. 16.

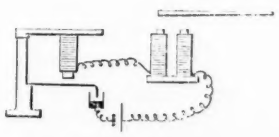


Fig. 17.

tuning fork. In the more recent patterns of instrument this is effected by a vibrating reed chronograph. Fig. 17 is a diagram of such an apparatus, and is self-explanatory. Similar apparati have been constructed by Despretz and Pfeil.

A very interesting phenomenon in connection with this branch of the subject is that known as the negative variation in muscle. It takes place as follows:—

If a muscle preparation giving a current between two points as previously described be tetanised by stimulation of its nerve, the tetanus will diffuse the whole mass of the muscle, but the change from rest to contraction will be greater at the equator than at the severed end. This gives rise to an action current in the opposite direction to the original current. The effect of this secondary current is to diminish the intensity of that which previously existed during tetanus, and it is this reduction in intensity which is known as the negative variation. A single stimulus is sufficient to produce it, but a better effect is obtained by a series of shocks. The researches of Sanderson and Gotch place the negative variation of E.M.F. accompanying a muscular contraction as exceeding the E.M.F. of the original current by 0·04 volt.

Another phenomenon, known as the diphasic variation, consists of three phases. An uninjured muscle has tapping electrodes applied to its extremities, and is then stimulated by a pair of electrodes arranged nearer to one end than the other. The first phase is brought about by the unbalance state of the muscle between the stimulated end which commences to act immediately, and that farther away, which takes a certain period to receive the impulse. The second phase occurs when the two ends of the muscle balance, that is to say, when the wave of contraction embraces both, and the third when it finishes in the original area of stimulation, and passes off at the nether extremity.

One of Galvani's experiments, made with a view to proving the existence of animal currents, consisted in supporting a nerve muscle preparation on a glass plate, lifting the free end of the nerve with a glass rod, and allowing it to touch some portion of the muscular surface at a point distant from that at which the nerve enters the muscle. The result was that the muscle contracted.

The so-called secondary contraction is produced in a similar manner. Two muscle-nerve preparations are supported on a glass plate, in such a manner that the nerve of one makes contact at two separate points on the muscle of the other. On stimulating the remaining nerve both muscles contract, the contraction of the independent muscle being caused by the electrical variations in the muscle of the first. Kühne has also demonstrated that if two muscles be pressed together, excitation of the nerve of one will cause contraction of both.

Taken together, the study of the electrical conditions of muscular fibre form an extremely interesting subject, and one which is likely to develop considerably within the next few years under the influence of scientific research.

ELECTRIC EARTH CURRENTS VIEWED ASTRONOMICALLY.

By ARTHUR E. COTTERELL.

(*Concluded from page* 596.)

On suspending the hemisphere by means of thread, or axially pinning it on a board so as to lie exactly within the area of the dial, it was possible to readily examine the relative position of the magnetic poles when the point marked to represent Valencia, Ireland, was turned to any hour of the day or night, and obviously a wider range of examination would be easily gained by marking other localities.

Anyone repeating this experiment will readily notice the following approximate points, which are very striking.

At noon, in Ireland, when the earth currents are at their easterly maximum (+), the south magnetic pole is at its

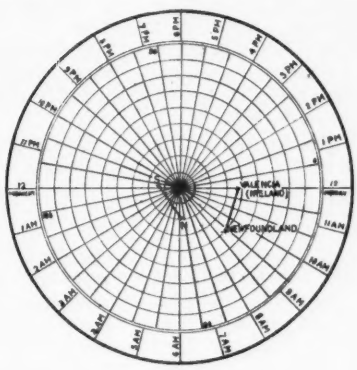


Fig. 1.

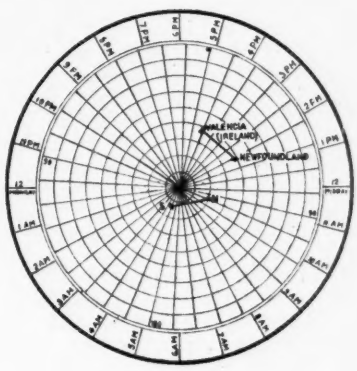


Fig. 2.

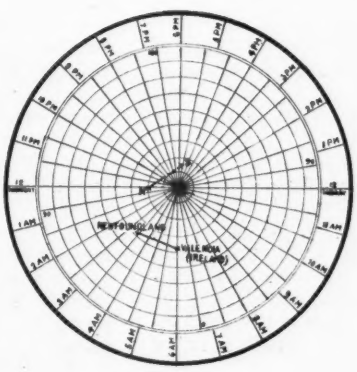


Fig. 3.

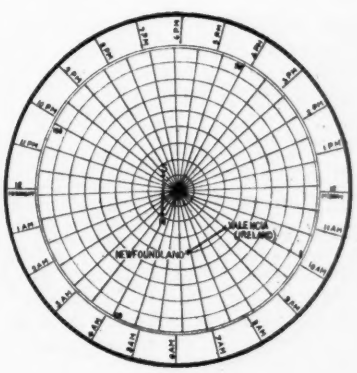


Fig. 4.

farthest position from the sun (which latter is obviously situated in the line of noon) (fig. 1).

At 4.30 p.m. the westerly maximum (−), the north pole is approximating to its nearest position (fig. 2).

There are other interesting instances, however, where the

magnetic poles assume critical positions at certain hours of the day when we observe varying phases of currents, *e.g.*, at about 6 o'clock a.m, the north pole is at its greatest distance from the sun (fig. 3). At 9.30 a.m. the north and south poles are in a rectangular position in relation to the sun (fig. 4). It will be remembered that it has already been stated that the westerly morning currents are noticed between 6.30 and 9.30 a.m.

Again, in the afternoon, the westerly currents which start with the north pole *towards* the near position, continue from 2.30 p.m. till 10.30 p.m., and in this connection it should be noted that the magnetic poles again assume a rectangular position at about 10 o'clock p.m. (fig. 5).

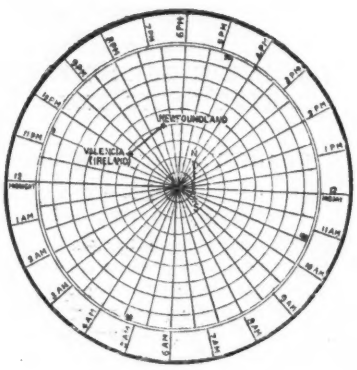


Fig. 5.

Of course it must be remembered that the axis around which the earth rotates, whilst practically parallel to itself throughout the year in the earth's orbital revolution, assumes from the angle in which it is placed different relations to the sun, and therefore in order to test the theory, it is eminently desirable, as this may cause some variations of the magnetic polarity, that a most careful and exact record should be taken throughout the whole year.

Data of this character necessitates greater facilities than the author has at his command, but enough has been said, he thinks, to warrant not only the deductions and theory laid down, but to encourage those who have the necessary facilities to examine and note the desirable information.

Such data should then be compared with a chart or sphere representing the magnetic location for the actual year when the records are taken.

As to the relative position of the sun's magnetic meridian we know nothing, but we can probably safely be content with the knowledge that the earth's magnetic position is, in relation to the sun, contemporaneous with certain diurnal effects in the shape of earth currents, and moreover, although the sun may have, and most probably has, magnetic properties of its own, nevertheless, from the fact that the rotation on the solar axis occupies some 27½ days, it may be, I think, reasonably inferred that the diurnal currents are not likely to be affected by any rotation of solar magnetism except in the question of intensity, no matter what degree of eccentricity the sun's magnetic polarity may occupy, and it will be obvious that any such suggested variation in intensity will be gradual only.

It has already been stated that lines which run between N.E. and S.W. are those most particularly affected by earth currents, and it may be as well to note that such a direction approximates towards right angles to the major axis of the earth's present magnetism. This point is important when we remember that it is necessary, in the case of electro-magnets, that the wire be wrapped in this manner on the core, and in this connection it is worthy of notice that the Atlantic cables between Valencia and Newfoundland follow this direction.

With these facts before us, the author trusts that other data may be forthcoming which will only serve to verify the deductions laid down.

But the subject even then is far from exhaustion. In the first place, it is known that the declination of the earth's magnetism is subject to considerable variation; in other words, the magnetic poles shift their geographical position, the cause for which is at present quite unexplained. What a field is here opened to an astronomical electrician, if such a title or description may be coined.

The following table of declination as recorded at London is not without interest, though their value is undoubtedly diminished by the irregularity of the records. The author has added the two last columns, showing the mean extent of variation for purposes of comparison.

Year.	Declination.	No. of years.	Variation.
1580	11° east.	...	...
1622	6° „	42	5° W.
1657	0° „	35	6° W.
1665	1° 22′ west.	8	1° 22′ W.
1701	9° „	35	7° 35′ W.
1800	24° 7′ „	100	15° 7′ W.
1818	24° 41′ „	18	34′ W.
1850	24° 30′ „	32	2° 11′ E.
1867	20° 50′ „	17	1° 40′ E.
1880	18° 35′ „	13	2° 15′ E.
1891	17° 42′ „	13	53′ E.

It will be noticed that considerable differences arise in the variations within periods of similar length, nor do the other records seem proportionate. We must remember, however, that the movements of the earth are very varied, and it is highly probable that these magnetic variations are due to either one or other, or more probably a combination of several of those motions which are extended over lengthened periods.

Let us suppose, as has herein been suggested, that the whole universe is in a magnetic state, and even then the rotation and orbital movement of the earth would only serve, perhaps, to slightly shift the magnetic meridian, not vary its power; indeed, it is known that the declination is slightly varied at different hours of the day. It is apparent, therefore, that the daily movement is such that a daily mean is practically maintained, and this continues throughout the year. But, as we have seen, the mean varies from year to year by a gradual process, and therefore we must look for some explanation of this variation which will probably be found arising from the precession and nutation of the earth's axis.

The precession of the earth's axis is a conical movement, which completes a revolution in about 25,867 years, and the nutation is another conical movement of shorter duration, viz., some 18⅔ years, a movement which describes a circle around, as it were, the major circle of precession. It seems, therefore, to the author that there must be at two immensely wide and distant points a north and a south pole of a huge magnetic system pervading the enormous universe of which our earth is but, as it were, an almost immeasurable atom, and that the axis of our magnetic polarity, and also those of the teeming millions of the denizens of space, are governed by the relative position which we and they variously occupy in the "lines of force" of a huge magnetic influence which binds the mighty and wondrous hosts of the starry realms.

Here we may do well to remind ourselves that not only do we notice a daily variation of declination, but also that this variation has a greater magnitude in summer than it has in winter, viz., 12′ in the former, and 7′ in the latter. When we reflect on the orbital journey of the earth, we see suggestion for such a theory confirmed by the facts of the case.

And in conclusion, as it is impossible to refrain from carrying speculation farther and deeper still, let us carry our thoughts to the geological structure of this earth of ours. How comparatively meagre our researches in this direction are, and have been, none but a geologist would admit, and yet enormous and untiring devotion has been so ably applied, and with such excellent results, too. Among the investigations, however much we may deplore the want of a complete geological survey of this planet on which we live and have our being, we note with pleasure and pride that that section, which is our England, has been carefully placed under able scrutiny.

A glance at a geological chart reveals one striking feature, viz., that the strata of our own islands run N.E. to S.W.

Can it be that the various strata, with their various constituent parts, form a huge and gigantic electro-magnetic wrapping round the enormous magnet which intersects our earth, promoting as a whole a healthful and benificent cur-

rent energy, by means of which vegetation is encouraged, and humanity stimulated and maintained?

Such thoughts rush in upon us with an irresistible force, and open up vistas of unexplored depths, the immensity of which we hardly dare attempt to span. We can but stand on one side and exclaim with halting breath: "Lo, these are but a portion of His ways, and but whisper of His glory."

THE USE OF ACCUMULATORS IN CENTRAL STATIONS OF ELECTRIC TRAMWAYS.

THE following notes are abstracted from a communication on the above subject by Ludwig Schroeder to the *Elektrotechnischer Verein*.*

The Zurich-Hirslanden Line.—This line was inaugurated in 1894; its length is rather less than three miles, and its contour is very irregular, including one gradient of 6·5 in 100, for a length of 132 yards. The cars, numbering 16, are small, carrying 14 persons inside, and six on each of the two platforms, their weight being about 5·5 tons when empty. Each car is furnished with a single motor of 20 H.P. made at the Oerlikon works. The generating station contains two boilers, whose heating surface is 623 square feet, and which supply vapour at a pressure of 148 lbs. per square inch; two compound vertical engines by the Oerlikon firm developing 100 brake horse-power, and turning at the rate of 240 turns per minute, each driving by a belt a shunt dynamo supplying 60 kilowatts at 550 volts.

Since February, 1896, the battery of accumulators has been arranged in shunt, as shown in fig. 1, and contains

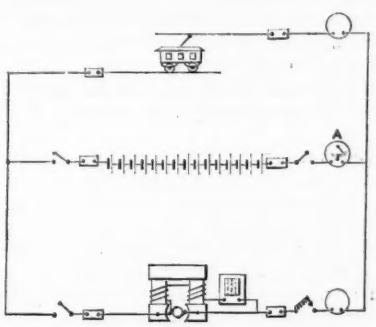


FIG. 1.

270 cells. This plan of mounting the accumulators has given complete satisfaction, the only inconvenience being that the light of the incandescent lamps on the car is not quite steady. An amperemeter and a voltmeter is mounted on each branch of the circuit in order to record its efficiency.

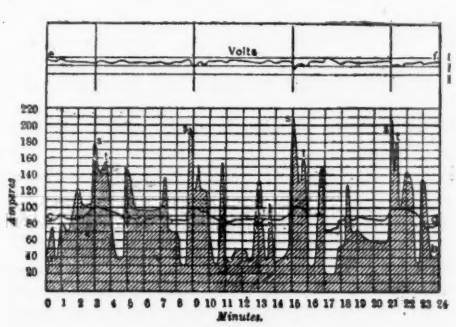


FIG. 2.

The results obtained by this arrangement are shown by the curves in fig. 2; the curve, *a b*, representing the intensity of the current supplied to the line at every instant, the curve, *c d*, the intensity of the current supplied by the dynamos, and the curve, *e f*, the corresponding pressure on the feeders.

Though the current consumed by the line varies from 20 to 210 amperes, the mean value being 90 amperes, the current supplied by the dynamo only varies between 72 and 102 amperes; but the extreme values are seldom reached, and the output of the dynamos generally lies between the limits of 85 and 90 amperes. The voltage varies only between 535 and 560 volts.

To make it clear how the battery acts in regulating the voltage, some explanations are necessary. If a battery is charged with a current of given intensity, the electromotive force at the terminals of the battery will at first rise abruptly to a certain value, *a b*, fig. 3, which is proportional to the internal resistance of the battery; then it will rise slowly, as

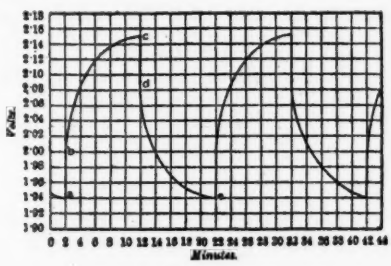


FIG. 3.

represented by the curve, *b c*, till it attains its maximum value at *c*, at which it will remain, so long as the current does not change its direction. If, now, the battery is discharged with a current of the same intensity as the charging current, the E.M.F. falls abruptly by an amount $c\,d = a\,b$, and then slowly. When a battery is used in the supply of a tramway line, the direction of the current is constantly changing, and the part of the curve, *b c*, and its inverse, *d e*, are consequently reduced to a very small size. In this case almost the whole variation of the current is due to the variations of *a b* and *c d*, which are due to the internal resistance of the battery. To obtain a good regulation, it is, therefore, necessary to use a battery whose resistance is as low as possible.

From the point of view of economy, the use of accumulators has been not less satisfactory. The battery, in this installation, has been in constant use for two years and a half, and has not yet shown any signs of wear and tear.

The consumption of coal per car kilometre has fallen to 1 kilogramme, which is a very small amount, when we consider that the number of cars in use is very small, and that the line comprises several heavy gradients.

The Brockenzell-Tettnang Line.—This installation differs considerably from the preceding, owing to the nature of the traffic. Moreover, the battery was installed to allow any augmentation of the traffic, without installing new groups of generators.

The battery consists of 318 Tudor cells, divided into three batteries of 106 elements each; it furnishes a normal current of 30 amperes, but is capable of momentarily reaching a

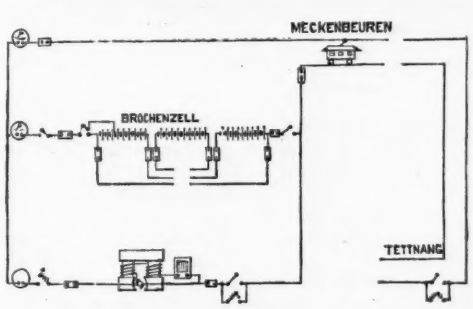


FIG. 4.

current of 160 amperes. The maximum intensity of the charging current is 72 amperes.

Fig. 4 shows the way in which the batteries are mounted;

* *L'Eclairage Electrique*, t. 13, No. 41, p. 78.

it is, in principle, the same as the preceding, but modifications in detail have been introduced, for the following reasons:—The generators are incapable of furnishing a higher E.M.F. than 700 volts, which is insufficient to completely charge 318 elements. During the day all the elements are connected up in series, and used together; in the morning or the evening, when the traffic is completely stopped, the battery is charged to saturation, one of the batteries being cut out of the circuit by means of a commutator. Each of the three batteries is cut out at regular intervals of time, while the other two are in circuit, with the result that all are equally charged. Moreover, since in case of accident to the hydraulic machinery at Brockenzell, the continuance of the service is assured by an auxiliary steam generating plant at the other end of the line, the drop of potential on the line can be allowed for, by cutting out 35 cells of the battery, which can thus still be made use of.

The results obtained have been very satisfactory, as may be seen by an examination of the curves (figs. 5, 6 and 7).

Fig. 5 shows the current used during the passage of a train weighing 46 tons, from Meckenbeuren to Tettnang. The batteries are connected in shunt with the dynamo. The

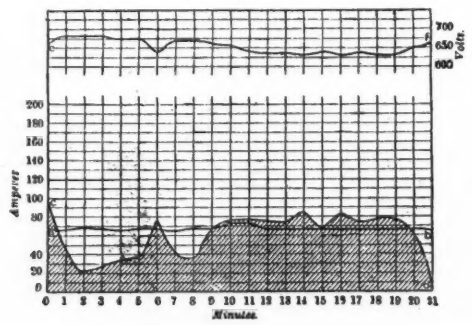


Fig. 5.

intensity of the current supplied by the dynamo is nearly constant (line *a b*), though the current, *c d*, supplied to the line varies within wide limits. The variations of potential are also very small, namely, from 620 to 680 volts, though before the installation of the battery, the potential oscillated between 300 volts, and more than 800 volts. These variations are, however, greater than on the Zurich line, because the batteries, instead of being charged and discharged at short intervals, supply or absorb current for periods of 5 to 10 minutes, the consequence being that the parts *b c* and *d e* of the curve, fig. 3, become of more importance.

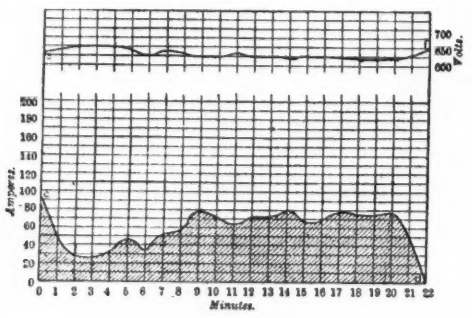


Fig. 6.

Before the installation of accumulators, it was impossible to have more than one heavy train at a time on the line; but now several trains can be put on without difficulty. The curves in fig. 7 were obtained when two heavy trains, 45 and 48 tons respectively, were mounting gradients. The variations of potential do not exceed the limits of 605 and 655 volts.

The curves in fig. 6 were obtained when the line was fed by the accumulators alone; as was to be expected, the voltage varies much less than in the preceding case, since the elements are not alternately charged and discharged.

The Remscheid Line.—This line, established in 1892, has a total length of 11 km. (6·6 miles); it has a very undulating profile, only 55 m. of its total length being on the level; it presents very long and heavy gradients, some of which are

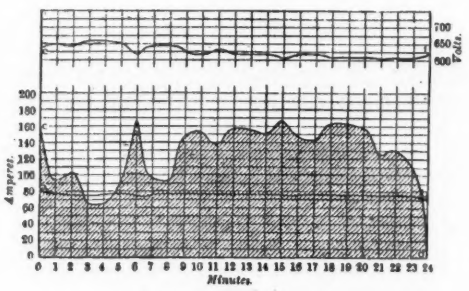


Fig. 7.

as much as 10·6 in 100. The cars hold 16 persons inside and 12 on the platforms. On weekdays eight cars are run, and on Sundays 12. During weekdays motors in about 40 neighbouring workshops are fed, making the charge at that time stronger and more regular.

The power station comprises three Steinmüller boilers, each having a heating surface of 120 m² (1,291 square feet), and supplying steam at a pressure of 120 lbs. per square inch: four Macintosh & Seymour engines of 160 H.P., and 435 revolutions per minute; four dynamos of 100 kilowatts at 500 volts.

The undulating nature of the track constantly causes considerable variations in the current. The output varies at any moment, on weekdays, between 100 and 400 amperes, and on Sundays between 0 and 450 amperes, so that the engines have to be constantly watched. But the mean value of the output on weekdays was only 232 amperes, and on Sundays 135 amperes.

The traffic increasing, as well as the number of motors installed, it became necessary either to instal a new group, or to utilise the reserve machine. It was decided to instal a battery of accumulators. The results obtained with the battery have been excellent, since it has been possible to work the Sunday service with one dynamo, and the weekday service with two, and the price of the battery was not half that of the dynamo, thereby set free to meet a further increase in the traffic.

The battery comprises 250 Tudor cells, of a capacity of 648 ampere-hours, with a normal discharge current of 216 amperes, capable of being increased to a maximum amount of 420 amperes.

The way in which the battery is mounted differs fundamentally from the plans adopted in the two preceding installations. The compensating system of Siemens and Halske,* which is illustrated diagrammatically in fig. 8, is employed. The generator, B, supplies, in the first place, a lighting system, L^3 L^4. In shunt with this are the feeders, L^1 L^2, leading to the traction system, C C. In the lead, L^1, is intercalated one of the coils, E^1, of the compensating dynamo, Z. The armature of this dynamo, and the accumulators, A, form a shunt to the principal circuit. A second magnet coil, E^2, is in shunt with the accumulator, A, and acts on the magnetic circuit in the opposite direction to E^1. When the traction system is receiving its normal current the two coils, E^1 and E^2, exactly balance each other, and the armature of the dynamo, Z, has no effect; but if the current in L^1 L^2 suddenly increases, the compensator, Z, reinforces the E.M.F. of the battery; if the traction current falls below the normal, the coil, E^2, then preponderates, and the compensator charges the battery A. In the compensator used at Remscheid, this compound winding is not applied directly to the magnet of the compensator, on account of its large size (600 amperes and 100 volts); but to a small exciting dynamo which supplies the current to the coils of the large compensating dynamo. An electromotor of 90 H.P. drives the two dynamos, which are mounted directly on its axis.

* *L'Eclairage Electrique*, t. IV., p. 158, July 27th, 1895.

The compensator is used only in the evening when the lamps are lighted, in order to obtain as constant a light as possible. For the supply of motors only, the battery in

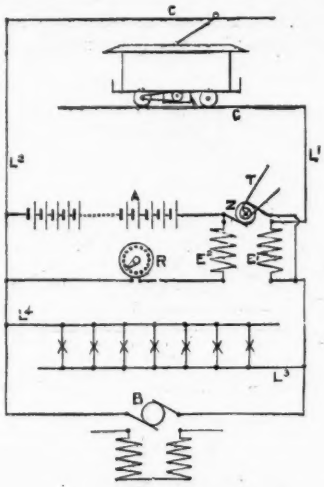


Fig. 8.

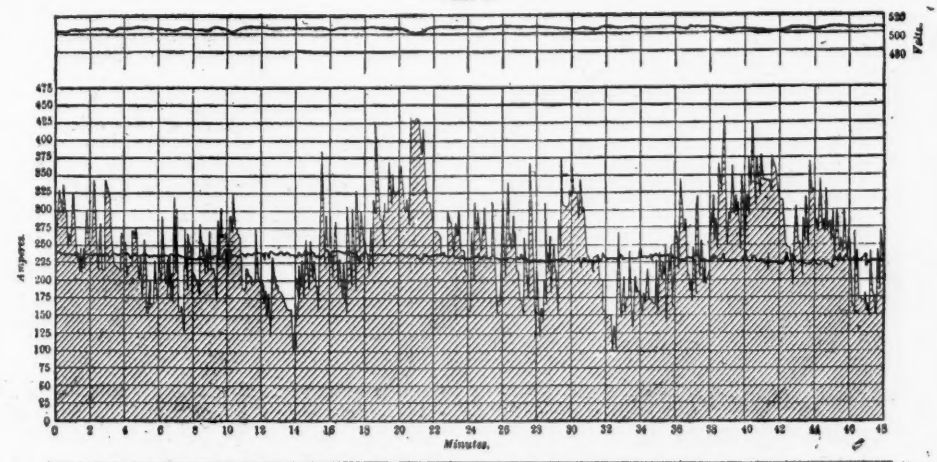
shunt is used. The variation of potential in the last case does not exceed 15 volts.

Fig. 9 represents the variations of current on week days, eight cars and the motors being in use. The current consumed varies from 100 to 460 amperes, while the current furnished by the generators varies merely from 210 to 255 amperes, with a mean of 232 amperes. The voltage is very regular.

Fig. 10 was obtained on a Sunday, with eight cars, and no motors in circuit, the compensator not being in use. In the afternoon, with 12 cars in use, the current consumed varied from 0 to 450 amperes, with a mean of 200 amperes.

The saving in coal since the accumulators were adopted, is estimated at about 11 tons per week.

Fig. 9.



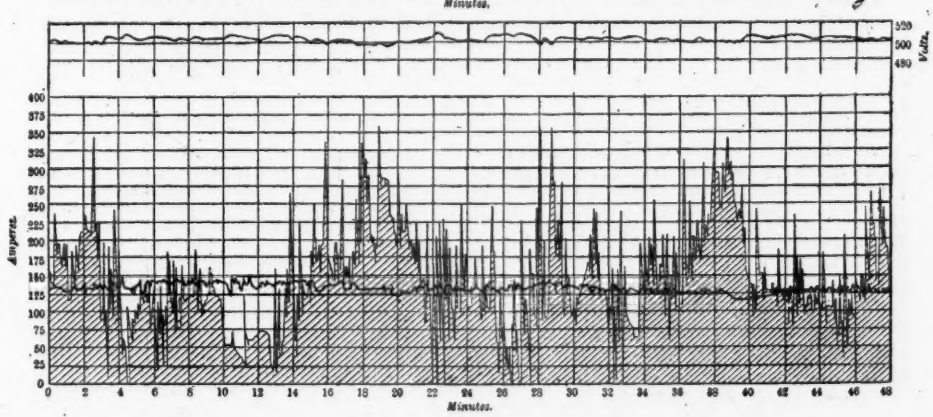


Fig. 10.

A SIMPLE METHOD OF STARTING ALTERNATING SINGLE PHASE INDUCTION MOTORS.

By Riccardo Arno.*

All single-phase alternating induction motors, as now constructed, require to be started as rotary field motors. For this purpose the inductor part is wound up with two separate circuits; the supply current circulates into the main winding during the regular run; while the other is intended only to carry, in the starting period, an auxiliary current, displaced in phase with respect to the principal one.

We propose herewith to expose a simple method of starting,† which permits of accomplishing the operation with the help of the main alternating current only.

This result is obtained by:

1. Inserting, during the first moment of starting, a resistance of a proper value in the circuit of the armature.

2. Impressing to the rotary part of the machine, just a very small initial velocity, by the sense of which the sense of the run remains determined.

3. Reducing the additional resistance up to nothing, gradually, as the maximum speed which corresponds to it is attained.

It was ascertained‡ by the author that the starting resistance to be introduced in the armature is such as to have the virtual value of the current in the main circuit, nearly double of the value attained under the same load, while the motor is running. This is also the condition satisfied when starting the motor by the usual methods.

Practical experience has proved that such an impulse as is communicated by giving a pull to the belt or rotating the armature by one quarter turn—accordingly as to whether the motor starts under no load or a very small load—is sufficient

* Read before the Associazione Elettrotechnia Italiana, Sept. 22nd.

† Patents are applied for.

‡ The experiments of the author were carried out on an induction motor of 3·5 H.P. constructed by Messrs. Brown, Boveri & Cie, the frequency was 40, the voltage 100, and the speed 1,250 revolutions per minute.

to initiate the motion. Hence the method proposed is not only very simple, but practical, and suited also for motors of large powers.

The results of the experiments are easily explained if we consider the single phase motor as a differential rotary field motor, and deduce its properties directly from those of the polyphase motors.*

Let B stand as well for the induction in the rotary field as for one-half the maximum value of induction in the alternating field; n, the frequency of both fields; S, r and L, respectively, the surface, the resistance and the inductance of each of the N elementary sections of the armature; m the number of revolutions per second.

Then the torque acting on the armature of the polyphase motor is given by

$$K = \eta N B^2 S^2 \frac{r (n - m)}{r^2 + 4 \eta^2 L^2 (n - m)}$$

while the corresponding torque on the single-phase motor is†

$$K' = \eta N B^2 S^2 \left[\frac{n - m}{r^2 + 4 \eta^2 L^2 (n - m)^2} - \frac{n + m}{r^2 + 4 \eta^2 L^2 (n + m)^2} \right].$$

In fig. 1 a line is plotted down with the values of m as abscissæ (to the left of O_1), and the values of K as ordinates;

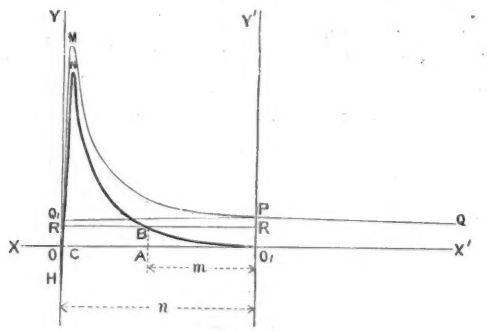


Fig. 1.

the curve consists of two branches symmetrical with respect to O, and only one of which is represented in the figure. Both branches are asymptotical to $O_1 x$, and have a maximum ordinate in M; this is $K^0 = \frac{N B^2 S^2}{4 L}$, and corresponds, for the branch herewith considered, to a speed $m^0 = n - \frac{1}{2\eta} \frac{r}{L}$. The curve has in O a point of inflection, and its inclinations there amounts to $\frac{\eta N B^2 S^2}{2}$.

It follows that by increasing r, m diminishes, while K remains always the same; thus the point M is shifted along a line parallel to $O_1 x$ from left to right, and approaches at first the axis, $O_1 Y'$ (see fig. 2), until it reaches it (fig. 3), and goes beyond afterwards (fig. 4). At the same time the inclination of the curve in O being inversely proportional to r, diminishes correspondingly; this is shown by figs. 2, 3 and 4 in the three cases, which are especially interesting of r slightly less than, or equal to or larger than $2 \eta n L$.

The lines constructed represent the torque, K, on the polyphase motor as a function of m; from these we may deduct the curves which correspondingly represent the torque, K′ of the single-phase motor.

This is done by drawing, with respect to $O_1 y'$, the symmetrical line to the portion, P Q, of the line constructed, and taking the differences of the ordinates for same values of abscissæ.

The lines O_1 N C H (fig. 1, 2, 3) and O_1 N_1 N H (fig. 4) thus obtained clearly show the various properties of the single-phase induction motors in the four cases which we have considered.

When the velocity, m, increases from zero up to O C (figs. 1, 2, 3), the torque K′ varies from zero up to a positive

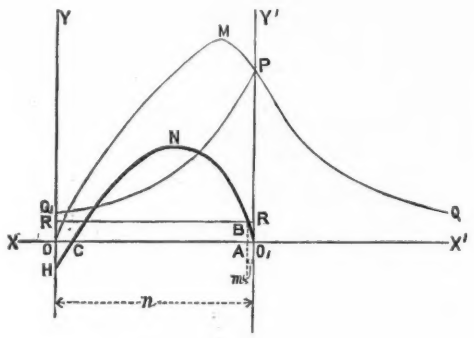


Fig. 2.

maximum, and down to zero again; it takes a negative value when m is larger than O_1 C. However, if the resistance inserted in the armature is such as to have $r : 2 \eta n L$ (fig. 4), then whatever the value of the speed may be, K′ is always negative; in all these cases the machines cannot be operated as a motor.

Taking $r = 2 \eta n L$ (figs. 1, 2, 3), it is to be observed that when r is small (fig. 1) O_1 C is slightly inferior to n, and

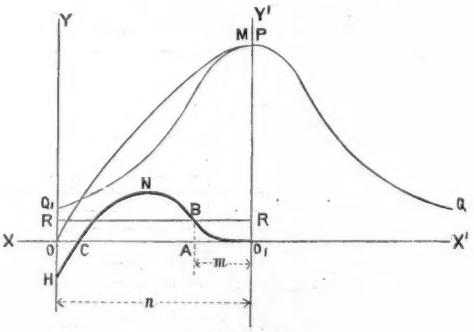


Fig. 3.

the maximum value of K′ slightly inferior to the maximum value of K; when r is comparatively large (figs. 2, 3), the differences between O_1 C and n and the difference between the maximum K′ and the maximum K are larger; they increase

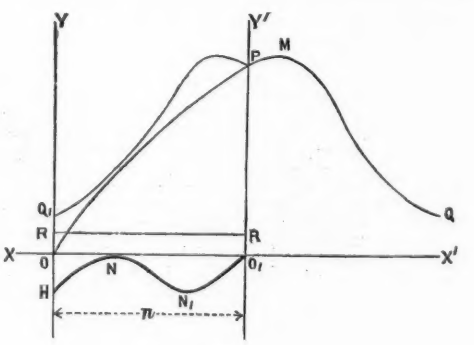


Fig. 4.

both as r increases, until $r = 2 \eta n L$ (fig. 3), after which the motor is stopped.

Now let the ordinate of the horizontal line, R R, represent the resisting torque to be overcome; this line meets the curve in B. In order to start the motor it is necessary to reach a speed higher than that corresponding to the abscissa of B.

* Galileo Ferraris, Un metodo per la trattazione dei vettori rotanti od alternanti ed una applicazione di esso ai motori elettrici a correnti alternanti. Memorie della R. Accademia delle Scienze di Torino, Serie II., tom XLIV.

† J. Sahulka, "Theorie der Tomson's chen, Browns's chen Motoren fuer gevoehnlichen Wechselstrom." *Elektrotechnische Zeitschrift*, July 7th, 1893, page 391. Galileo Ferraris, *op. cit.*

The value of this starting speed, for a given torque, may be very small when R is slightly less than $2\ \eta\ n\ L$, while it is always comparatively large in all other cases.

The condition of r inferior, but by very little inferior, to $2\ \eta\ n\ L$, is then the proper one to be satisfied, in order that a quite feeble initial speed impressed to the rotary part of the machine, may cause the starting under the sole action of the alternating current.

The case of $r = 2\ \eta\ n\ L$ corresponds to the best starting conditions of the polyphase motors, as for $m = 0$, the value of K is a maximum; we may thus say that the additional starting resistance to be inserted in the armature winding of the single phase motor is by little inferior to the starting resistance of the polyphase motor.

It has been already observed, and it results from figures evidently, that $2\ \eta\ n\ L$ is the maximum value of r, above which, for certain values of the speed, the torque is negative; then another rule to fix the proper value of the starting resistance of the alternate induction motor is to take it slightly inferior to the maximum value above which the working of the machine is no longer possible.

A Simple Method of Starting Alternating Simple-Phase Induction Motors.*

In a former paper the author explained a new method of starting single phase induction motors, which allows the operation to be accomplished by the help of the supply current only; the auxiliary current usually resorted to being dispensed with, even at the moment of starting.

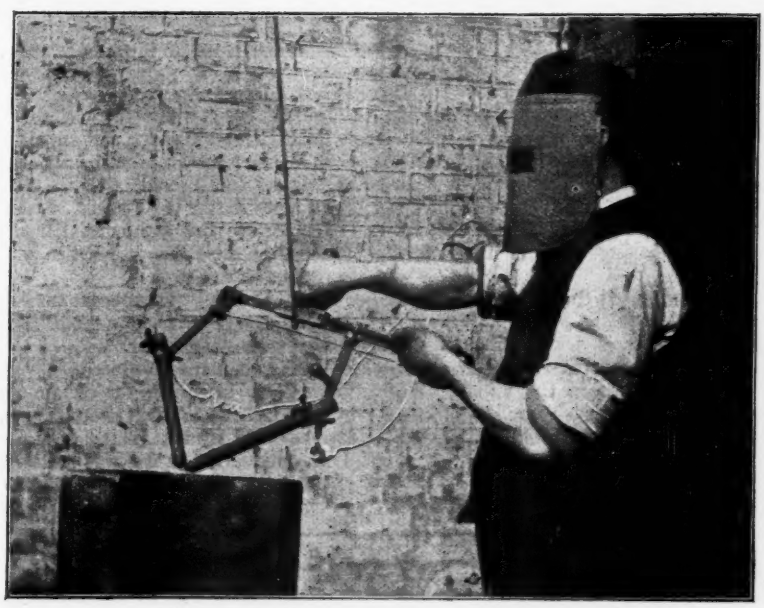
This method consists of:

1. Inserting, during the first moment of starting, a resistance of a proper value in each elementary winding of the armature; this is chosen such as to make the value of the whole resistance of the corresponding circuit slightly less than $2\ \eta\ n\ L$, L being the inductance of the circuit, and n the frequency of the current.

2. Impressing on the rotary part of the machine a very small initial velocity, such as is maintained by rotating the pulley by one quarter turn, or giving a pull to the belt.

3. Reducing the additional resistance up to nothing, as the maximum speed which corresponds to them is attained.

The methods of starting adopted up to now are all dependent upon the production of a Ferraris field and its actions on the short-circuited armature; they always require, for motors above a certain power, the employment of additional resistances to be inserted during the starting period in the armature sections. This shows what an important simplification is obtained by the application of the new method, as well in the construction of alternate induction motors as in their starting apparatus. Indeed, the auxiliary winding on the inductor, and the reactance device to produce the phase difference between the two currents are both dispensed with.



The Voltex Process of Electric Welding (see page 756).
Fig. 1.—Workman Ready to Weld Plates of a Boiler.

As the value $r = 2\ \eta\ n\ L$ is the value of the best starting resistance for polyphase motors, it may be said, and is verified by experience, that the additional resistance to be inserted in each section of the armature circuit, in order to start the alternate induction motor, is slightly inferior to the best starting resistance of the same motor when used as a rotary field one.

It results from theory that $2\ \eta\ n\ L$ is the maximum value of r, above which, for certain values of velocity, the torque is negative; thus the starting resistance of the alternating motor may also be determined by taking it slightly inferior to the limit above which the working of the machine as a motor is no longer possible. This is also a result confirmed by experience.

As noted in the former paper, the first experiment on the proposed method was carried out by the author on a 3, 5 H.P. Brown motor, installed in the electrical laboratory of R Museo Industriale, in Turin. The results obtained being favourable, in order to properly judge of the technical importance of the method, further experiments were necessary.

It was possible for the author to accomplish a new line of experiments, owing to the special kindness of Mr. C. Sutermeister, the proprietor of the electrical works of Intra, of Mr. A. Croppi, technical manager of same, and Mr. G. Merizzi, the manager of the electrical works of Sondrio, who, taking a great interest in the new method, gave ready help towards carrying out the tests. The author is glad herewith to express to these gentlemen his sincerest thanks.

The three motors, distributed on the single alternating distribution of Intra were constructed by Messrs. Brown, Boveri & Cie; they work respectively at the speed of about 600, 800, and 400 revolutions per minute, developing 12, 25 and 110 H.P.

The ordinary method of Brown, which consists of generating a phase difference in two inductor windings by the help of an electrolyte, had been resorted to up to now in order to start these motors under the only load of the belt and the loose pulley. The first two motors, of 12 and 25 H.P., are low-tension (110 volt), the third one high-tension, 3,000 volt; the frequency of the alternate circuit was 42.

Having started these motors by the new method, under the only load due to the belt and the loose pulley, not only were the results formerly obtained perfectly verified, but also a new and remarkable result was obtained, that is, in correspondence with the starting resistance inserted in each elementary winding of the armature, the virtual value of the alternating current in the inductor circuit, in the first moments of the initial period, was nearly the same as that absorbed, under the same conditions of load during the regular run of the motor. This condition is far more advantageous than the one verified when starting the motors by the artificial generation of a rotary field.

For these reasons, and after a special license for the new method was obtained from the author, the system was permanently adopted for starting the motors installed in the electric plant of Intra; this afforded the opportunity to practically

* A communication read by Prof. R. Arno at the General Convention of the Associazione Elettrotecnica Italiana, in Milano, October 24th, 1897.

show that the method is not only much more simple and economical than those hitherto employed up to now, but is also, by far, more advantageous.

THE VOLTEX PROCESS OF ELECTRIC WELDING.

In the Voltex process, the apparatus consists of a carbon holder and a pair of carbon electrodes. In using the apparatus, an arc is struck between the electrodes, and owing to the material of which these are made, and their arrangement in the tool holder, a powerful flame like that of a gas blow-pipe, but of much greater range of temperature, is projected from between the adjacent ends of the electrodes, and is directed upon the material to be heated.

The workman, therefore, by merely varying the distance of his work from the electrodes can apply to it a blow-pipe flame of a temperature ranging at will from that of the arc itself down to a temperature comparable to that of an ordinary gas blow-pipe.

By varying the voltage by means of a regulating switch, the power of the blast can be still further increased or diminished at will.

Beyond a make and break switch, preferably one controlled by the foot, and a regulating switch if the same tool has to be used for a very wide range of work, the whole of the apparatus required is shown in fig. 1, though the tools may also be used in conjunction with the various kinds of machines used for pressing or hammering together the metals to be joined, as, for example, in welding iron or steel.

The process is thus a simple one, and the tools may be moved from place to place in the workshop or factory as may be convenient.

Fig. 2.—Workman Ready to Braze a Joint.

In figs. 1 and 2 a workman is shown ready to use one of the larger tools for welding together the plates of a boiler. In order to facilitate the manipulation of the tool and to take its weight off the workman's hands, it is suspended from one end of a cord passing over a pulley, the other end of the cord being attached to a balance weight, or if preferred, an elastic cord may be employed, having one end fixed overhead.

In fig. 2, a workman is shown ready to braze together two pieces of steel tubing to form a T-joint.

It will be seen that the process is very similar to the Zerener arc system, the only observable difference being that the electro-magnet is dispensed with in the Voltex. We believe, however, that the claims of novelty in the process relate to a special manufacture of the carbon electrodes.

ELECTRIC CABLE TRAMWAY.

Whose the fault may be, it is difficult to say, but there has from time to time been manifest, since the great developments began in electric traction, a strong feeling of antagonism between those interested respectively in cable and electric systems. The former have, perhaps, good grounds for dissatisfaction, seeing that the introduction of trolley wires has led to a change of equipment upon many cable roads; and an authority regarded as a usurper is never altogether relished.

Some tramway interests, however, have very wisely seen many good points in both systems, when installed in the services for which each is best fitted, and there ought, as a matter of fact, to be no serious rivalry between them. With heavy and frequent traffic on roads with heavy grades, there is nothing to beat the cable in economy of working cost, although the enormous capital outlay required, and the presence of a slot in the street surface, are very strong counterbalancing disadvantages.

There is no good reason, however, why the two systems should not be jointly worked with successful and satisfactory results. In any district where there is a network of lines, there is sure to be one or more that might advantageously be operated by cable, or the services in the central and more crowded districts might all be carried on by cable, leaving the suburban traffic entirely to the overhead wire.

This would necessitate the cable cars hauling in the trolley cars as trailers over the city streets, and two-car trains in that way might prove as great a nuisance as trolley wires throughout. However, the suggestion is worth making.

In other cases, where there is perhaps one heavily loaded or graded line whilst the rest are all very suitable for trolley working, it seems a pre-eminently sensible plan to instal an electric service throughout with the exception of the one line for which the cable would be run by means of an electric motor supplied with current from the main power house. That is, the cable line is practically a separate unit worked from its own sub-station.

It is obviously more economical both in first cost and working charges to instal a motor for such a purpose instead of a separate steam plant.

Such a system is now successfully at work in Kansas City, where cable machinery for certain services, hitherto driven by a 24 inch by 28 inch steam engine, is now operated by a four-pole 300 kilowatt motor.

The line served in this way has a length of about 2¼ miles of double track, with grades as heavy as 10 per cent. and a 19 hours' daily run is kept up. The motor has on occasion pulled 20 grip cars with 25 trailers during several hours in the day, according to the *Street Railway Review*, from which we note these particulars.

The motor is nothing but a converted generator, re-wound for a speed of 380 revolutions instead of the usual one of 480 as a generator. It is connected by means of a double leather belt 36 inches wide to a large fly-belt wheel 24 feet diameter, keyed on an extension of the intermediate cable winding shaft, and any slack in the belt is taken up by an adjustable jockey pulley placed in an upright frame between the motor and fly-wheel.

The speed regulation is so arranged with resistances, &c., that it may be varied from 10 revolutions up to the normal one of 380 per minute. The change of load is very great as the service demand varies; at one time the cars may be

running down hill, and therefore drive the motor as a generator, returning current to the main power house and so to the rest of the system to the extent of perhaps 20 or 30 H.P. At other times it is called upon for an output of as much as 650 H.P. as a motor.

Fortunately these overloads do not continue long, and no trouble has been experienced from damage to insulation due to excessive currents, in some cases as much as 900 amperes.

The cost of operating this line by electric power in this way instead of by a separate steam plant, is stated to show very great economies, the expenses per month being only one-third of what they formerly amounted to. Even with the inclusion of heavy repairs as time goes on, the cost should still be very much less, whilst obviously in the installation of a new tramway system altogether (as opposed to the conversion of an existing line) there are important savings to be made in land and buildings, as well as operating plant, when electricity is employed.

CORRESPONDENCE.

Dust Destructors at Shoreditch.

I have read with much interest the letters appearing in your journal upon the above subject, but have hitherto refrained from any comment. The letter of the Chairman of Shoreditch Lighting Committee is, however, couched in a tone in which there is so much "human nature," that I am prompted to send you a few lines. The chairman says he is "nearly tired of contradicting the absurd reports, &c., &c.," and he is not pleased with your correspondent, "A Humbug Hater," but, if I mistake not, he (the chairman) will in the end be not "nearly" but *quite* tired, and be ready to admit that he has at last joined the ranks of the "Humbug Hater's." Referring to Jones's "Refuse Destructor," 1894, I find that the statistical Table F. gives Shoreditch a population of 124,000, inhabited houses 15,350. The chairman gravely tells us that from the "ashbin refuse," and by means of this marvellous arrangement of destruction, &c., &c., they are giving the extraordinary maximum output at heavy load of 250 kw., and the refuse of seven days of this vast population burnt in 5½ days has to be supplemented by coal on Saturday afternoon and Sundays.

The last remark in the chairman's letter is very striking. I will repeat it, "What other towns can do we neither know nor care, but what Shoreditch is doing is quite another matter." Now, Mr. Editor, although the chairman may "neither know nor care" when a particular system is being "boomed" all over the country, and we are told that "deputations and investigations from municipalities all over the kingdom were of daily occurrence," it seems to me that the chairman who presided over this particular "boom" should both "know and care." Refering again to the before-mentioned book, Table F, I find that in 1894 of 1,005 towns recorded as under the cognisance of the Local Government Board only 15 have a population so large as Shoreditch. I need say no more at present, but commend the foregoing to all concerned.

X. Y. Z.

November 22nd, 1897.

If Mr. Kershaw will only clear away the strange mystery that overshadows the steam power costs of the Shoreditch plant, by exposing the actual items of cost such as are asked for below, he will not be further disturbed with what he alone considers are such absurd reports. There is an impression abroad that the system of power generation at Shoreditch is not by any means an economic one, but is both *dear and nasty*. The replies to the following queries will enable us to judge how far this impression is justified.

The two figures given by Mr. Kershaw prove nothing beyond the very remarkable fact that from the combustion of some 60 tons of refuse, of exceptionally combustible quality, per diem. This relatively enormous weight only develops at the heavy load a paltry 250 kilowatts.

Now, Mr. Kershaw, here are the questions:—

First. What is the capital cost (exclusive of the ordinary refuse burning cells, the cost of which we know) of the steam generating, hot water containers, steam engines, and all the associated apparatus that enables the 250 kw. to be developed.

Second. How much coal per a given month is employed, on the Saturday and Sunday nights, and at what cost.

Third. What is the actual output per this given month in kw. units.

When we have replies to these interrogations, we can easily compare the fuel cost of the plant, and its working cost, with, say, a high class steam or gas engine plant.

It is conceivable that the believed very heavy first cost of the Shoreditch plant, and the great depreciation that must be allowed for a plant subjected to the objectionable conditions of a refuse burning factory, will make the cost of running very much higher than that of a modern coal fuel, gas, or steam power plant.

For the reputation of the Shoreditch Vestry, it is necessary that a clear and unrestricted *exposé* of the figures of cost should be given, and this without fear or favour.

Power.

Temperature Variations in Clark Cells.—A Correction.

I trust you will allow me to correct a mistake in your report of the last meeting of the Physical Society. In the discussion, I wished to draw attention to the fact that when using a Board of Trade form of Clark cell under ordinary working conditions, rapid changes of temperature being avoided, it is unnecessary to trouble about "lag" if the absolute value of the E.M.F. is in question, because this is not known to a greater accuracy than one tenth per cent. (not *one* per cent. as reported); and, even if the accepted value of the volt be taken as correct, the E.M.F. in this form of cell is not reproducible to a greater accuracy than one tenth per cent. When, however, we are not concerned with the actual value of the E.M.F., but only with its constancy, the question of "lag" may be a serious one. The importance of "lag" depends simply on the experimental conditions—a fact which does not seem to be always appreciated.

W. R. Cooper.

Large Power Distributing Scheme.

I notice with interest (from your reference in this week's issue of the Electrical Review to the above) that there is some probability that we shall soon see, even if on a contracted scale in Yorkshire and Derbyshire, the distribution of electric power from the coal fields, so ardently projected by Mr. Thwaites some years back.

If this scheme is really carried out it cannot fail to constitute a precedent that will certainly be acted upon all over the manufacturing centres of this country, so therefore let us hope that the scheme referred to may soon be an accomplished fact.

Electric Power.

Professors and Engineering.

Being familiar with the locomotive testing plant at Purdue University and with the methods pursued and the work done there, though not connected with the institution, I beg to make a few comments upon the editorial on "Professors and Engineering" which appeared in the Electrical Review of October 22nd, page 540. With those who have knowledge of the facts, the article in question goes to prove rather than disprove, the accusation of unfairness to the professional cult.

The locomotive testing plant at Purdue was built in 1891, and a locomotive of the American eight-wheel type purchased by the University. The experiments made on this apparatus have extended over a period of six years, and cover a wide range of investigation. The results of all the tests have not been published, though a considerable portion have. A *resumé* of the first two years' work may be found in the *Transactions* of the American Society of Mechanical Engineers; the work done on exhaust nozzles in the *Proceedings* of the American Railway Master Mechanics' Association and many minor papers have appeared in the technical papers and the proceedings of various railway clubs.

During the present year the University has sold the old

locomotive and purchased another which has been especially designed for experimental purposes. The saddle castings and steam piping are such that the engines may be readily changed from simple to compound; there are duplicate cylinders 20 inches by 24 inches with bushings to reduce the diameters to 16 inches, and a low-pressure cylinder for compound working 30 inches by 24 inches, with a set of bushings for reducing the diameter. The boiler is designed for a working pressure of 250 pounds per square inch.

This plant is one of the two now existing where locomotive tests of scientific value may be made. The second is that built by the Chicago and Northwestern Railway Company at its shops in Chicago, for the purpose of testing the locomotives of that company. It will scarcely be urged that the officials managing that road are as foolish as you have painted the "engineering professor."

The statement made by you that "at Purdue University they have gone so far as to experiment on a locomotive of the ordinary type, and of a four-cylinder type, in which the pistons on each side move oppositely to each other and obviate the need of revolving weights, the reciprocating parts being, of course, self-balancing on each side of the engine," is grossly misleading.

The "wire" experiments on the engine of the ordinary type were made in the fall of 1893, and were reported in Vol. xvi. of the *Transactions* of the American Society of Mechanical Engineers at page 305 *et seq*. If any reasons are desired for the making of these practical tests I feel sure that you will find a sufficiency of them in the papers on counter-balancing that appear in the same volume.

The tests on the Strong balanced locomotive were made in the spring of 1897 at the request and expense of the manufacturers who desired to demonstrate that this engine was perfectly balanced. I feel safe in saying that the great majority of engineers will agree with you as to the folly of building a locomotive with four cylinders to show how the necessity of using counter-balances in wheels may be overcome. It was certain that a locomotive so built would be perfectly balanced, and a test could only show whether any mistakes had been made in calculating the weights of the various parts. But for this waste of time and money the manufacturers and not the Purdue University should be blamed, for the apparatus there (when not required for the purposes of instruction) is placed at the service of parties desiring to have commercial tests made.

In your statements you were no doubt misled by the account published in the *Scientific American*, and attributed the "suspecting" of the effect of rotating an unbalanced wheel to the professor; but that article was apparently only an attempt to stimulate the interest of our railroad engineers in the balanced engine, and the word suspect was ill chosen. Otherwise I fail to find in the article in the *Scientific American* statements to justify the position taken by you. I would submit that in any case your caustic comments on the work done at Purdue should not have been made without investigating the facts in question.

I will refrain from entering into any discussion as to the careless design of American locomotives, though issue might be well taken on that point.

D. R.

Chicago, *November 13th*, 1897.

Electric Heating and Welding.

With reference to the letter of your correspondent, signed "R" in the Jubilee number of your Journal, may I say that I shall be glad to show him electric welding and heating plants in operation either in Sheffield or elsewhere, if he will be good enough to inform me as to the nature of the application in which he is interested. I have a large number of these plants working and shall be pleased to submit any information.

T. Scott Anderson.

Royal Insurance Buildings,
Sheffield.

Personal.—We understand that Prof. Dewar, F.R.S., president of the Chemical Society, has received the Jubilee medal.

THE ENGINEERS' STRIKE.

Under the title of The Betrayal of the Engineers, "One Who Knows," and he seems to justify his signature, writes a very scathing article in the *Mariner*, in which he compares the A.S.E. as it was under its old management, when it could claim Mr. Burns's description of it as "the richest, largest, and one of the strongest trades unions in the world," and its present unenviable position, minus funds, and with a large body of discontented members who see too late, that in giving themselves up to their new executive, they were entering on the down grade of ruin. The writer speaks of the executive as the Tom Mann party, and he appears to exonerate Mr. Barnes from the responsibility of the present state of affairs, alleging him to be merely the nominee and tool of the said Mann party, and to have no more real say in the management than had the figurehead of a man-o'-war with the manipulation of the vessel it ornamented. Here are given the names of the executive, those marked with an * being classed as tools of the Tom Mann party:—David Gardiner, John Black, Alfred W. Golightly, *Albert Taylor, *Robert McDowell, Joseph Hooson, *Alfred Sellicks, John Gray, *George Ferguson, *Frank H. Rose, *James Ratcliffe, John W. Whittaker, *Albert Bigby, *Jenkin Jones.

If "One Who Knows" be correct, there was no compact between Mann and Barnes, but the latter was simply a nominee of the former, and if not the responsible head may be held somewhat excused from many of the hard things said of him. When out of the ashes of the A.S.E. as powerful a society rises up, the Tom Mann party will have to reckon therewith. To-day we are informed the engineers have to realise that their reserve fund of 40 years' growth has been dissipated by five years of the management and tactics of the present executive. When the late general secretary in 1890 addressed the members of the A.S.E. on the 40 years gone by, he pointed out among other figures that in one year, 1889, over £50,000 was put to one side as excess of income over expenditure, yet between 1851 and 1890, over three million sterling had been paid away on benefit, superannuation, and assistance to other societies. Then, in 1890, it was suggested that the Society was in need of reorganisation, and of being placed on a firmer basis, and so it came about at Leeds, in 1892, that the Mann party came into power. Well, the Society has been reconstructed and reorganised, and it has certainly been put upon a different basis. The wide scattering of its funds may by courtesy, perhaps, be deemed a broader basis, in that the funds at least are over a much larger area, and the Society is not likely to fall much lower, and is, therefore, in stable equilibrium. The late William Newton, who had so much to do with the earlier days of the A.S.E., said:—"In all cases where differences arise between an employer and his workmen, they (the executive) ascertain the ground of dispute. If the men are wrong, the executive exercise their influence to prevent them from proceeding in the wrong. If the employer be wrong, they endeavour to see him and reconcile the difference either by mutual explanation or mutual concession. It is not to be expected, among so many members and a large number of employers, that difficulties will not arise. Experience has taught the Amalgamated Society that, as a rule, these differences can be better arranged by the intervention of a third party than by those in personal dispute." When the new executive came into power, their first move was to increase the cost of the Executive Council from £10 to £40 a week; an advance of over £1,500 per year.

The writer does not desire to interfere in the present dispute, but desires the members of the A.S.E. to have the facts, and to learn that there are friends and helpmates willing to help them to expose the doings of the Independent Labour party, whose object is self-interest only, even though England be ruined, and workmen be compelled to take their belts in yet another hole for a meal. We omit much of the article from our review, because the writer evidently writes what he feels, and to do so in the present dispute tends to more forcible expression than may be deemed necessary.

In the meantime preparation for the much expected Conference drags apparently with little speed, and men hungering for occupation must be getting very impatient while their executive prepare to meet at the Westminster Palace Hotel. It appears to have been decided that all decisions of the Conference will have to be voted upon by the members of all societies involved. It also appears that the joint committee of the allied trades, in face of the terms of reference of the Conference, drawn up by the President of the Board of Trade, have actually refused to withdraw the strike notices served on London employers, and picketing is going on as usual. The employers, however, had suspended the strike notices, and so the A.S.E. continues to fiddle while Rome burns.

The Manchester branch of the Employers' Federation have now issued a second series of examples of restriction and interference. We need not detail these, but briefly, in place of work costing 41s., it now costs 15s. Work costing 36s. was taken to Havre and done for 28s. Work which cost so much in 1891, cost over 25 per cent. more in 1896 with improved machinery; and so the tale goes on, numerous trivial instances hardly worth citing by themselves going to swell a huge total, besides the surreptitious influence of the shop stewards, skulking and spoiling work deliberately. It is said that if a settlement be not quickly arrived at, many men in the Manchester district are ready to break away from the Society, and curiously enough this has been an inducement for the employers to consent to a conference, because they *do not wish to see a break up of the trade unions*, desiring to have some kind of central authority in cases of dispute. If the men would only believe it, it is not to trades unionism that employers object, but to the mismanagement of them on lines that cannot permanently endure. Germany continues to send help to the men, and German workmen are very busy patting the British workman on the back and telling him what a fine plucky fellow he is. In the meantime

the German workman is pleased and apparently contented to go on working his 12 hours a day, and the German employer is equally pleased to circularise all over England the fact that while the strike lasts (and Heaven alone knows how long afterwards) he will be glad to furnish all manner of things to English ship builders, electricity works, &c. Let the strike continue but little longer and there will be not very much work to begin upon. Indeed it is more than probable that one of the very first troubles after the strike will be the attempt of the strikers to turn out non-union men from the shops. If a single non-union man be thus evicted from his place it will be to the everlasting disgrace of the employers, who will deserve in the future all the evil that the Unionists can work on them. We point out this danger now as a timely intimation. The question is sure to arise, and the Federation would do well to be prepared to meet it in a bold and uncompromising spirit. It is time free men were protected from the tyranny of minorities, for in this world it is, as often as not, the minority who tyrannise over the more peaceful majority. Thus we see Trades Unionists tyrannising over all outside the fold, just as we see teetotallers tyrannising over all who differ from them, instead of working to secure rational treatment of disease.

The strike is now attracting more attention from abroad. A correspondent of *Engineering*, in Philadelphia, states that the American workmen are most desirous to see the strike continue, and hope when it does end that it will end in favour of the men; but at the same time they freely express their opinion of British workmen for being such "blithering idiots"—we quote from the letter in our contemporary—as to persist in their present course. We note a tendency in the American press to side with the men, while at the same time trying to commend American workmen for having more sense. We quite understand the feeling which prompts Americans to wish to see the downfall of engineering in England; but at the same time it seems to us that such a desire is simply the outcome of the very belated ignorance in economic affairs which stamps so many Americans. In this they strongly compare with our own trades unions. Americans are never so happy as when they see their best customers in trouble, and though Great Britain absorbs the bulk of their produce, the whole press of America pour abuse upon us without end, and would wreck us if they could. As Englishmen, we have no occasion to regret the progress of engineering either in Germany or America, so long as no folly of our own people deliberately gives our own trade away. England can well hold her own if trades union lunacy be only checked, and we would most emphatically call upon all who can to support the employers in this crisis. If the question of interference be not settled for good and all, the whole fight will have been useless. But we hope the near future will show that no mischief-maker will be tolerated in any shop, but will be speedily sent about his business. We should like to have spared room for the whole of the above-named letter from Pennsylvania, for it is evidently written by a man who has lost his patience with the men, and he was a member of the A.S.E. once.

The expected Conference was fixed to take place on Wednesday last. It is not a hopeful sign that the A.S.E. have tried to influence the public against the employers, because of the refusal to accept a single chairman. The employers are going into the Conference to withstand a demand that they shall expend capital under the direction of Mr. Barnes or his masters, and shall pay any man of Mr. Barnes's nomination just such wages as it may please Mr. Barnes to order. Naturally this looks all right to Mr. Barnes, so long as he does not see that the end of it all must be all round ruin. For our own part we do not for a moment doubt that if the men would return to work on the *status quo ante* it would not be long before they would easily gain an accession of wages, if they would drop the foolish idea that curtailing their own efficiency can be of any real service to them. One would think Mr. Barnes had had enough of flogging employers into federation. But no! Mr. Barnes talks about a huge union of all labour in the land as though he could effect this without at the same time compelling a still closer and greater union of employers. Mr. Barnes and his followers talk lightly of driving capital out of the country. They will follow the work they say. We think we see some of the blatant sort of men, of whom we have lately had experience, going over to Germany for work, where they would work 50 per cent. longer hours, and get 30 per cent. less money, and if they opened their mouths to grumble, would find themselves in prison, and quickly, too. The ideas of the A.S.E. on foreign tolerance must be delicious. Let no employer believe the matter is settled, writes *Engineering*, on reading Mr. Barnes's Stratford speech. We agree, but we can hardly agree in our contemporary's view that the demands of the men's leaders have been made in ignorance of economic laws, and not from self-seeking motives. It is very pretty of *Engineering* to say this; at the same time, it is a little uncomplimentary to the leaders' intelligence. To our view, these leaders have done all they have done entirely from a No. 1 standpoint. Their motto has been, it will last my time, and after me the deluge, and possibly engineering in England might have seen their span of life out even on their lines—sufficiently so to have paid them their salaries. Most of us, however, have some care for posterity.

At the time of going to press the daily papers record the first meeting on Wednesday of the Conference. Let us hope wisdom will prevail.

LEGAL.

HOLOPHANE COMPANY *v.* O. BEREND & Co.

On Friday last, in the Chancery Court of Mr. Justice Kekewich, Mr. Warrington, Q.C., in the action of the Holophane Company *v.* O. Berend & Co., asked his Lordship to grant an interim injunction, until the trial of a patent action, restraining the defendants from offering for sale, or supplying for sale, globes manufactured according to or in the manner described in the specification filed in pursuance of the letters patent No. 19,185, of 1893, granted to S. Psavondaki and A. Blondel, and advertised by defendants under the title of opterophane globes.

The patent, the learned counsel said, was granted in 1893, and being recent, its validity had not yet been established. The object of asking for an interim injunction pending the trial, was because at the time of the commencement of the action plaintiffs were selling, and for some time had been selling, a considerable number of their globes; whereas the defendants, when the action was commenced, had not begun, but were merely advertising their intention to commence the trade. Therefore, on the ground of the balance of convenience, even if it should turn out at the trial that plaintiffs were not entitled to an injunction, it would be better to stop this incipient infringement, of course on the plaintiffs' undertaking in damages, rather than allow it to go on, because if defendants were permitted to sell these globes, which were of an inferior kind to those made by the plaintiffs, and manufactured in Germany, the reputation which the plaintiffs were gaining might be seriously injured. Without delivering a lecture on the science of optics involved in the case, it might be sufficient if he indicated very briefly the character and design of the plaintiffs' globe. The object was its use with a powerful light, such as the arc or other forms of electric light, so contrived, that the light, instead of appearing in a point, should be diffused over the entire surface of the globe, arrangements being made for preventing the rays of light being lost by what was called interior reflection; and another point in plaintiffs' invention was the configuration of exterior ribs, so as both to refract and reflect the light. The defence set up was anticipation by a patent taken out by a Mr. Trotter some years ago, and which, so far as its inner and outer ribs were concerned, was like plaintiffs; but in other respects it differed, its outer ribs being so contrived that there was no reflection, and the light thrown upwards would be lost without a separate reflector over the top. The globes looked exactly like the plaintiffs' globes, the names also were much alike, and the plaintiffs said if they were allowed to be placed in the market they would lose the reputation they were now acquiring. He also proposed to put in an article of Mr. Trotter's in the ELECTRICAL REVIEW in November, 1894, disclaiming the idea that the plaintiffs' invention was any infringement of this; but to the reception of this Mr. Terrell, for the defendants, objected, and went on to say that they set up two defences—first, common knowledge, and next anticipation by a prior patent. They further said, and filed an affidavit by a director of the company detailing the facts, that some years ago a German firm widely circulated in this country a circular bearing on globes, showing that the chief ideas claimed by the plaintiffs were not new, the diffusion of light being well known here before the date of the plaintiffs' patent. To this affidavit, and Mr. Terrell's submissions, Mr. Warrington objected that it was clear Mr. Trotter had not in his mind the controlling effect of the plaintiffs' reflecting prism, or the saving effect of their concave-convex prism, and that the validity of the patent was not at the moment before the Court, but whether plaintiffs were to be damnified by the defendants' sales.

In the result Mr. Justice KEKEWICH said in these cases there must be something more than a mere challenge of validity; but he saw no ground for supposing that there was here a mere sham designed to defeat the plaintiffs' procedure. He thought he had no power or right at this stage, in the whole circumstances of the case, to restrain the defendants from doing what was complained of; but they must undertake to keep an account of their transactions in anticipation of a question which remained to be tried, the costs of this application to be costs in the cause.

BUSINESS NOTICES, &c.

Application for Extension of Patent.—The Judicial Committee of the Privy Council will on Thursday, December 9th, at 10.30 a.m., hear a petition by I. A. Timmis for an extension of the term of letters patent No. 5,718 of December 12th, 1883, granted to S. C. C. Currie, of 21, Clarges Street, Piccadilly, gentleman, and I. A. Timmis, civil engineer, now of 2, Great George Street, S.W., for an invention "of improvements in the means of working and interlocking railway signals by electricity."

"Ajax" Enclosed Arc Lamp.—Messrs. Beanland, Perkin and Co. have issued a revised price list of this arc lamp. Nine different patterns are now made; Types A, B, and G being usually carried in stock, for direct current only, series or multiple use. The Flemish and Rococo types are extremely ornamental, and suitable for fine work. The mechanism is the same in all lamps. By recent improvements in manufacture, the firm are announcing reductions in the price.

Dinner.—An interesting ceremony took place at the large hall of the Crystal Palace, Leipzig, on Friday last, the 19th inst., in the form of a dinner given by Messrs. Korting & Mathiesen, of that city to their employés, numbering several hundred, to celebrate the fact of the firm having on that day brought the total of arc lamps manufactured and sold by them to the large figure of 50,000. There were a number of toasts. We understand that this firm's agent in this country, Mr. G. Braulik, of 218, Upper Thames Street, E.C., is booking some large orders.

Electrical Wares Exported.

Week Ending Nov. 23rd, 1896.	£	s.
Albany	40	0
„ Teleg. mat. ...	11	0
Amsterdam	50	0
Beira. Teleg. wire ...	430	0
Bilbao. Teleg. mat. ...	126	0
Bombay	253	0
Brussels. Elec. cable .	1,310	0
„ Teleg. mat. ...	52	0
Calcutta	213	0
Cape Town	306	0
Colombo	19	0
Delagoa Bay	64	0
Durban	522	0
East London	214	0
Flushing	285	0
Genoa	54	0
Launceston	175	0
Madras	10	0
Orotava	104	0
Port Elizabeth	479	0
Rio Grande de Sul ...	60	0
Rockhampton	160	0
Rotterdam	17	0
Singapore	265	0
Sydney	4	0
Trinidad	22	0
Wellington	219	0
Total	£5,880	0

Week Ending Nov. 23rd, 1897.	£	s.
Alexandria. Teleg. mat.	58	0
Amsterdam	40	0
Antwerp	120	0
„ Elec. fuses ...	574	0
Bangkok	51	0
Barbadoes	16	0
Barcelona	10	0
Bombay	10	0
Brisbane. Teleg. mat.	8,803	0
Calcutta	51	0
Cape Town	1,057	0
Channel Islands ...	12	0
Cologne	15	0
Colombo	379	0
Durban	464	0
East London	810	0
Flushing	15	0
Fremantle	4,597	0
Gibraltar	94	0
Gothenburg	42	0
Hamburg	289	0
Madras	50	0
Malta. Teleg. mat. ...	90	0
Melbourne. Teleph. mat.	1,114	0
Naples	45	0
Ostend	400	0
Panama	17	0
Rotterdam. Teleg. mat.	47	0
Shanghai	15	0
Singapore	61	0
Sydney	436	0
Townsville	390	0
Vera Cruz	20	0
Wellington	558	0
„ Teleg. mat.	550	0
Yokohama	290	0
Total	£21,854	0

Foreign Goods Transhipped.

	£	s.
Brisbane. Teleg. mat.	12	0
Fremantle „ „	38	0
Sydney	265	0
Total	£315	0

Bankruptcy Proceedings.—At last Friday's sitting of the London Bankruptcy Court, held before Mr. Registrar Linklater, Wm. Marshall, mining and electrical engineer, 16, Tokenhouse Yard, E.C., applied to pass his public examination upon accounts showing gross liabilities £15,390, of which £6,701 are unsecured, and assets valued at sufficient to yield a surplus of £54,560. In the course of his evidence, the debtor stated that he started the Tokenhouse Yard business in 1894, with £1,500 capital. He financed the inventors of certain electrical patents, and in that way expended between £6,000 and £7,000. Then in May, 1896, he promoted the London Electrical Omnibus Company, Limited, with a capital of £250,000, to acquire the plant and patents. As vendor, he was to receive £20,000 in cash and £80,000 in shares. The initial expenses amounted to about £14,000. The public subscription did not come up to expectation, and eventually he returned £13,816 of the cash consideration, and took up the unsubscribed balance of 27,633 shares. He valued his shares in the statement of affairs at par, but they would not realise that amount until the omnibuses started running. Witness attributed his appearance at the Court to loss in connection with the City of Mexico Tramways, and to his inability to immediately realise his shares in the London Electrical Omnibus Company. The Registrar pointed out to the debtor that his large surplus was contingent upon the full face value of the shares being realised, and asked him whether he did not desire to amend the accounts. The debtor replied that he would stick to his guns, as he confidently expected to realise the full amount in due course of time. The examination was concluded.

Under the failure of S. Bousfield Tatham, electrical engineer, 26, Thurloe Place, South Kensington, the first meeting of creditors was held last Monday at the London Bankruptcy Court, before Mr. A. H. Wildy, official receiver. The debtor formerly acted as salesman to a firm of electrical engineers, and was in receipt of a salary of £200 a year, which included royalties on an electrical appliance that he had brought out and patented. He left that firm in 1889, and commenced business in partnership at 16, Davis Street, Berkeley Square, under the style of Girdlestone, Tatham & Co. He retired from that partnership in August, 1895, in consequence of disagreements caused by his over-drawing. The present business was started in January, 1896, and was continued by the debtor until last October, when the stock, fittings, and fixtures were sold under an execution debt. Extravagance, betting, and law costs are stated to be the causes of the failure. In the absence of any offer, the case was left in the hands of the official receiver to be wound up in bankruptcy. December 14th has been fixed for the public examination of the debtor. The accounts show liabilities £2,558 15s. 7d., and assets £65 5s. 10d.

Dissolutions of Partnerships.—Messrs. C. D. Abel, J. Imray, O. Imray, and H. Imray, carrying on business as consulting engineers and patent agents at Bank Chambers, Southampton Buildings, Chancery Lane, W.C., under the style of Abel & Imray, have dissolved partnership by mutual consent as from September 30th. The business will be continued by C. D. Abel and J. and O. Imray under the old style, and these gentlemen will attend to debts.

The partnership heretofore existing between Alice Westray and J. H. Ormrod, (Westray & Ormrod, electrical engineers, Church Street, Blackpool, and at St. Helen's) has been dissolved by mutual consent. Debts will be attended to by Alice Westray, who will continue the business as Westray & Co.

Liquidation Notice.—At a meeting of the New-Mayne Electric Rudder Motor Syndicate, held at Palace Chambers, Westminster, on November 13th, a resolution was passed winding up the company voluntarily, as it could not, by reason of its liabilities, continue business. Mr. D. F. Basden, of 33, St. Swithin's Lane, E.C., was appointed liquidator.

Catalogues.—Messrs. Elliott Bros. have issued a new edition of their mathematical instrument catalogue. Great attention has been paid to the illustrations, which are carefully and neatly prepared and arranged. The catalogue contains descriptions of theodolites, tachometers, curve rangers, mine survey instruments, Johnson's tripod heads, prismatic and other survey compasses, and surveyors' measuring apparatus. There are also current or tide meters, plane tables, range finders, planimeters, gauges, dividing machines, mathematical and drawing instruments, anemometers, indicators, pressure gauges, Mance's heliograph, and a large number of similar instruments. The catalogue is an excellent production.

Messrs. Frank Suter & Co.'s new price list of registered reflectors includes details and prices of several designs of reflectors for shop window lighting (inside and outside), also for show cases and show rooms. Messrs. Suter make a special line of reflectors of this class.

From Mr. D. J. Hauss, of Pike Buildings, Cincinnati, Ohio, we have received a small pamphlet describing, and dealing generally with secondary batteries for various purposes, including electro-medical work.

Ediswan Brushes.—The Ediswan "Sparkless Gem" dynamo and motor brush (Chaplin's patent) is made of H.C. copper wire (spongy). Its peculiar construction of this brush is claimed to ensure perfect contact with the commutator, even when much worn. The result is brought about by the spongy nature of the contact surface; and it is stated that with the lightest possible pressure the highest conduction is attained; sparking is prevented; wear on the commutator is reduced, and its temperature lowered.

Electric Wiring Contracts.—The contract for the electric wiring and fittings for the new Liverpool Head Post Office has been placed with the National Electric Free Wiring Company, Limited. There are 1,125 incandescent and 58 arc lamps in this contract. The West Ham Town Council have also accepted the same company's tender for the electric wiring for the new Technical Institute. This is for about 1,400 lights. The company has during the past two months carried out 60 installations with an aggregate of over 1,000 lights. In all of the foregoing installations their patent system of wiring is being used throughout. Under the free wiring system all these installations are said to be bringing in a revenue.

Fire.—Early on Wednesday morning there was a fire at the National Telephone Company's stores at James Street, Haymarket.

Gas.—Various gas explosions have been recorded in the London and provincial papers during the past few weeks. During the last day or two they have occurred at Gloucester and Cheltenham with the usual results, *i.e.*, wrecking premises, burning and injuring the occupants, and destroying furniture.

King's College Engineering Society.—At a general meeting held on November 19th, Mr. G. E. Summers read a paper on "Telephones." The author, after dwelling at some length upon the early history of the telephone, giving a full account of the growth of Bell's instrument, went on to describe the invention of the microphone by Prof. Hughes, and gave full details of transmitters from Edison's instrument to the Delville or solid back of the present time. In conclusion, the author described fully the various receivers and transmitters used in every-day life, and also gave a short sketch of the advancement of "Telephony" since the time when practical instruments were first brought to light. The paper was illustrated by diagrams and by several specimens of telephones. At the close of the meeting a vote of thanks was given to the Western Electric Company for their kindness in lending a number of telephones.

L'Accumulateur Sec Société Anonyme.—The Secretary of the Sussman Electric Miners' Lamp Company, Limited, writes as follows:—"With reference to your note in your last issue, of the formation of a company in Belgium, named 'L'Accumulateur Sec Société Anonyme,' I may mention that that company was formed for the purpose of acquiring this company's patents for Belgium, and that they have completed such purchase."

Sunderland Exhibition.—Lord Londonderry opened an electrical and engineering exhibition at Sunderland, on Monday afternoon. In the course of an address, he referred to the great improvements that had been effected in the sciences, shipbuilding, electricity, and engineering; also in matters naval and military.

(*Continued on page 765.*)

BRADFORD EXTENSIONS.

The new electricity works which have been recently completed at Bradford form the second stage in the development of municipal lighting in Bradford. It is hardly necessary to go into what is almost ancient history; but it may be mentioned that public electric lighting was commenced by the Corporation in 1888, when a two-wire system was adopted. This was subsequently modified by a three-wire system. The progress made at Bradford is in many ways remarkable, and there is very little doubt that the town has been fortunate in always having associated with its electric lighting system an engineer who was thoroughly alive to the growing utility of electricity. Mr. Gibbings, the present engineer, as well as his predecessor, Mr. Sydney Baynes, have not only shown marked ability in managing a town lighting system, but they have done much to develop and extend the use of electricity. The action of the Electricity Committee of the Bradford Corporation in reducing charges, has likewise helped to show the cheapness of electricity for small power purposes, and at the present moment there are motors whose combined horse-power reaches a total of 642.

To cope with the growing demand for electricity, it has been necessary to build new electricity works in another part of the town.

The building is at the corner of Valley Road and Lionel Street, and is plainly but substantially built in local stone in the renaissance style, adapted to the purpose for which the building is required.

The works are in one block, and divided into office buildings, fronting Valley Road; engine and dynamo room, behind offices; and boiler house, running parallel with Lionel Street.

On the ground floor of the former are the general offices for clerks and draughtsmen, lavatories, &c., opening out of a spacious entrance hall with tiled floor. A staircase leads up to the first floor, on which are a large committee room, 40 feet × 20 feet, with windows overlooking the engine and dynamo room and the electrical engineer's private office.

The basement is utilised for the condensing plant, comprising surface condensers and electrically-driven air pumps, and centrifugal circulating pumps. The exhaust steam pipes from the engines are brought under the floor of engine house.

All the floors of office building are of fireproof construction, built up of steel joists and cement concrete, and covered with wood parquetting.

The dynamo and engine room is 85 feet long, 61 feet wide, and 28 feet high to the steel roof, which is in one span, and boarded with pitch pine. Accommodation is provided for 12 engines and dynamos.

A 12-ton travelling crane runs the whole length of the engine house, and is supported by a cornice with arches and pilasters. The architraves and imposts of the latter are of specially designed glazed moulded bricks of a Rockingham brown colour. The whole of the engine house walls are lined with white glazed bricks above a dado of brown and buff glazed bricks.

The floor is tiled on concrete arches and steel joists, beneath which is a basement giving easy access to engine beds, electric cables, exhaust pipes, &c. All the switching arrangements are controlled from a platform which runs across one end of the engine house.

Owing to the nature of the strata in the valley bottom, it has been necessary to carry the walls of the building some 10 feet below the natural surface of the ground, and to lay broad footings of cement concrete to get a stable foundation; and in the engine house to sheet the whole area with a thick layer of concrete (on which the engine foundations are built), to ensure an equal distribution of weight and an absence of vibration.

The boiler house is 105 feet long, 48 feet wide, and 23 feet high, to the steel lattice girders which carry the roof. The latter is provided with large louvred ventilators for carrying away escaping steam, and sky-lights for giving light.

In order that the coaling arrangements may be expeditiously carried out, and with as little labour as possible, the coal carts enter by special entrance-gates in Valley Road, and after being weighed in the weigh-house, pass up a slight incline to a roadway running alongside the boiler house, from which the coals can be easily tipped through the large doorways direct into the extensive bunkers below.

For condensing purposes a cooling reservoir has been constructed near a brook, some 90 yards distant from the works. The water, controlled by a sluice, can be drawn from the brook through a settling tank into the reservoir. The latter is constructed of brickwork in cement, concrete, and masonry. Efficient cooling of the condensing water is attained by the architect's system of guide-walls, by which the water is given time to part with its heat by travelling a maximum distance before returning to the condenser. From the reservoir the water travels in large cast-iron pipes to a well — built of brickwork in cement and concrete—near the engine house, whence it is drawn by the circulating pumps to the surface condenser, from which it returns in open cast-iron troughs to the reservoir.

The engines are Willans' patent central valve triple expansion type, having three cranks at 120° apart, two of the engines being each of 600 I.H.P. when running at 300 revolutions per minute with a steam pressure of 180 lbs per square inch at the stop-valve; the cranks running in a bath of oil lubricating all the working parts by splash. The range of speed capable of being regulated by hand is from 270 to 300 revolutions per minute.

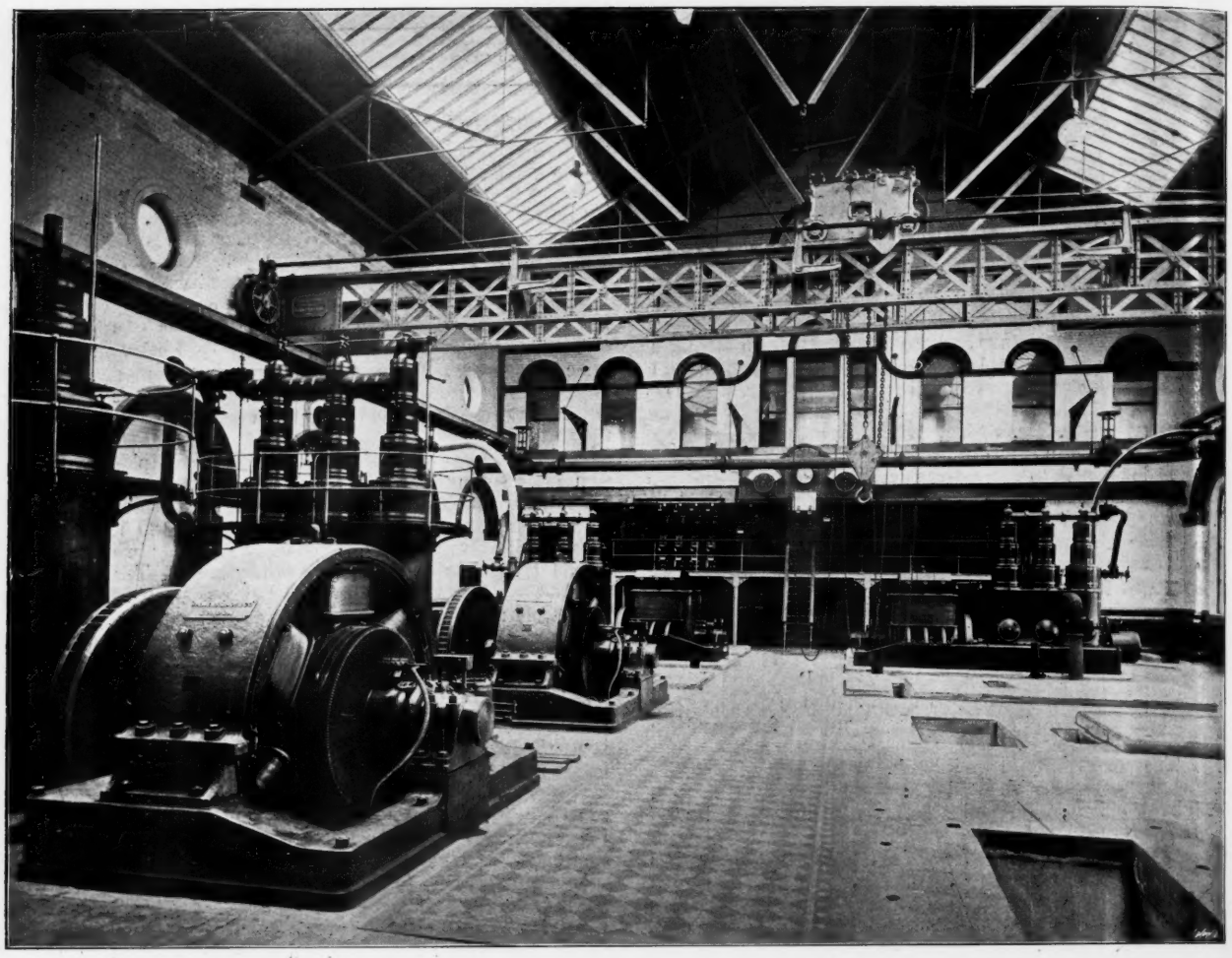
Two of the dynamos are of Siemens multipolar type, and coupled direct to the engine. They give an output of 750 amperes and 500 volts, at a speed of 300 revolutions per minute. The armature is of the usual Siemens drum pattern, with stranded bar conductors, but the diameter in this case is nearly twice the length of the pole pieces. The commutator has 211 segments, and there are two sets of brushes placed at 60° angular distance apart, each set consisting of three brushes. The armature resistance from brush to brush is less than one hundredth of an ohm. The weight of the complete armature is 6½ tons.

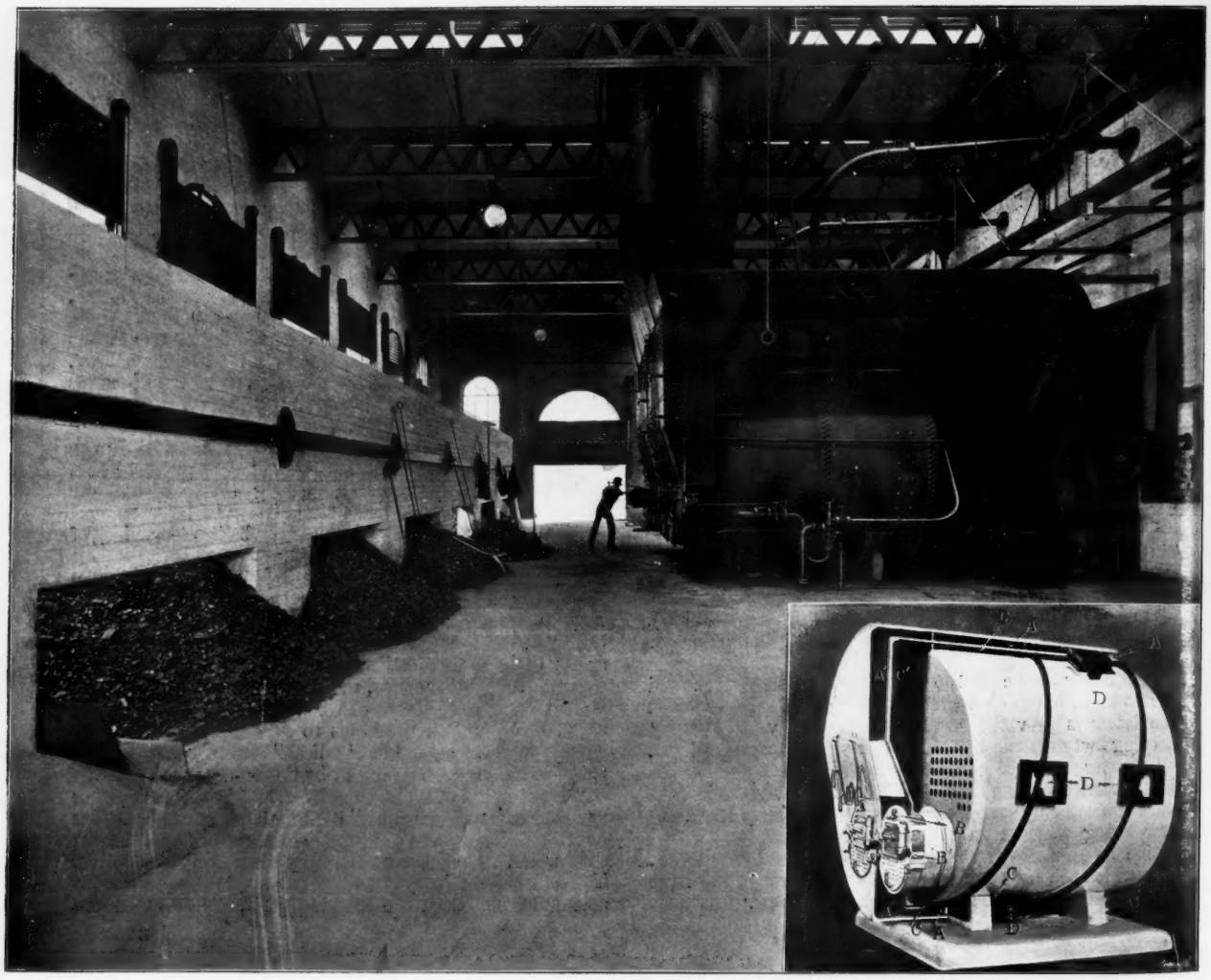
There are six field magnets arranged equidistant, inside a heavy forged iron ring, which forms the common yoke, and which is 8 feet in diameter over all. The pole pieces are rather more than 2 feet across, and the wire is wound on a wooden frame. All six magnet coils are connected in series, and have a total resistance of 41 ohms. They are connected in shunt to the armature, with an interposed regulating switch and resistance. The whole ring of magnets weighs 11 tons, bringing up the weight of the entire dynamo, inclusive of bed-plate, to rather over 21 tons. There are two other Willans-Siemens sets of 300 H.P. each, the dynamos being of the two-pole type.

Considerable interest attaches to the boiler house, for the type of boiler used is radically different from what one usually meets in electricity works. There are two of the marine type, made by Messrs. John Brown & Co., Limited, fitted with Ellis and Eaves's induced draught apparatus, each providing steam for 600 H.P. when working on a consumption of 20 lbs. of water per I.H.P., and capable when forced, of providing 800 I.H.P. They are 9 feet 9 inches mean diameter × 10 feet 6 inches long, and fitted with two Purves flues each, the diameter of flues being 2 feet 10 inches inside. There are in each boiler 110 Serve tubes, which are 3¼ inches outside diameter; the shell plates are 1⅛ inch thick, front and back end plates ⅞-inch, furnaces ½-inch, the working pressure 200 lbs. per square inch, and grate area 34 square feet. It is stated that at the 6½ hours evaporative test, 626 H.P. was obtained easily, burning 40 lbs. of coal per square foot of grate per hour.

By reference to the illustration of the boilers, some idea of the draught system may be gained.

The cold air for the combustion of the fuel enters from the back end of the boiler, passing along the outer space, A A′, to the valves, B and B′, in furnace fronts; on its way this cold air is guided round the outside of the "inner" space, C, in a "helical" direction by partitions set up as shown. After combustion, the waste hot gases leaving the boiler pass through the smoke box into inner space, C, and are made by similar partitions to pass round and in close contact with the boiler in a "helical" direction on their way to the suction fan. The boiler, by these means, is thoroughly enveloped in the escaping heat, effectually preventing either "radiation," "condensation," or straining of the boiler under forced conditions, such as rapid generation of steam from cold water, or sudden and greatly increased evaporation. The cold air on its way to the valves also absorbs a large amount of heat from the escaping gases, and so enters the

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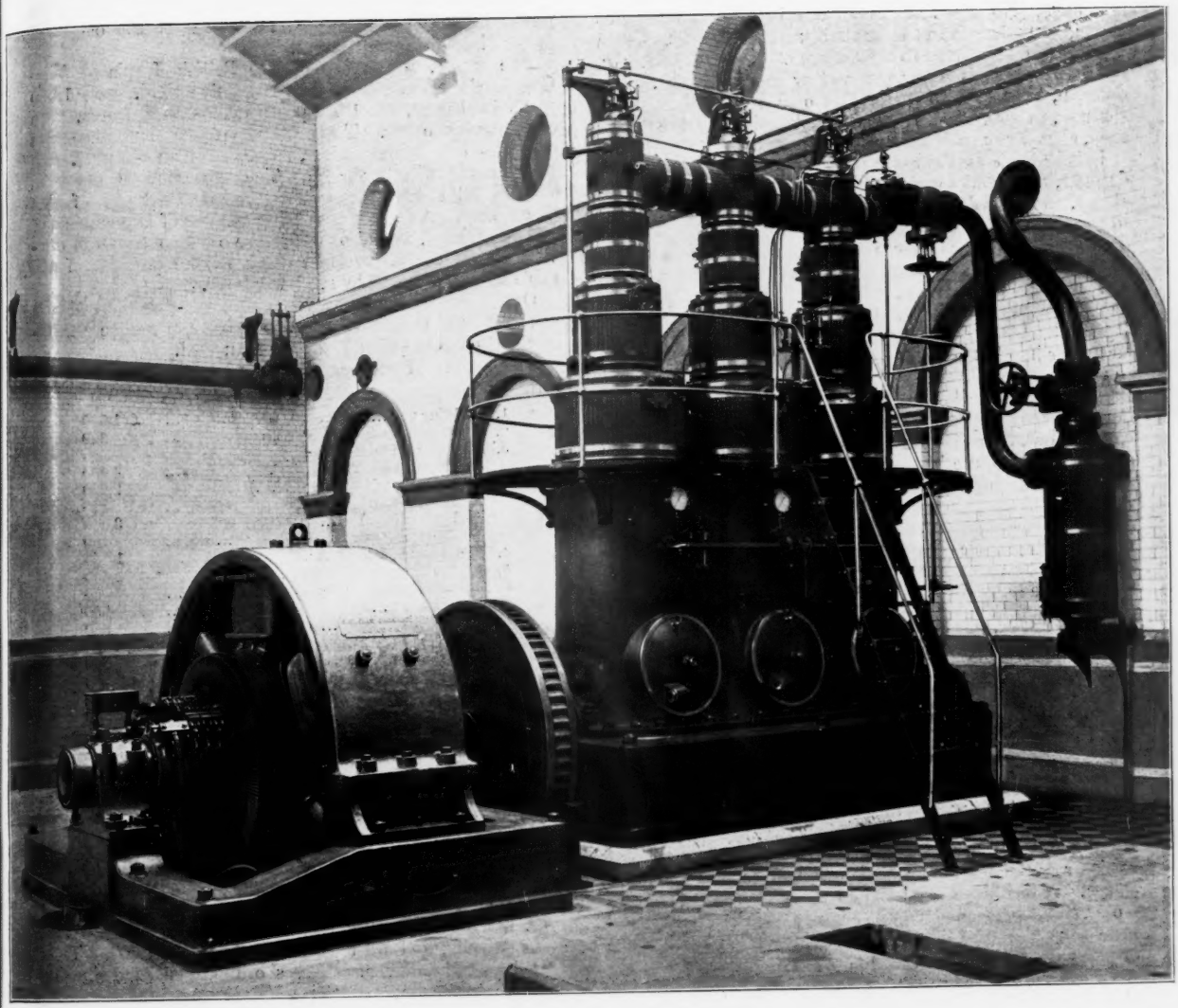
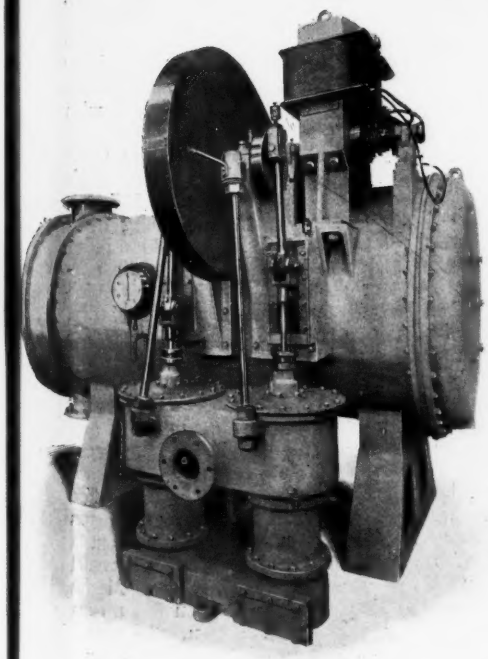
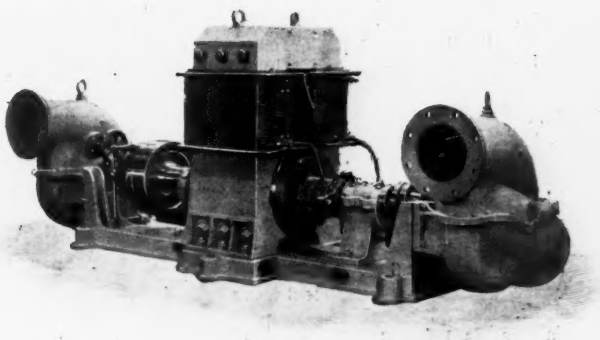


Willans-Siemens Multipolar Set.



Condensing Plant



Motor Driving Pumps.

furnaces at a greatly increased temperature with resultant economy. No blocking up of the bottom boiler tubes through any deposit in the smoke box can take place, as such a deposit, if any, drops to the bottom of the inner casing, C, from whence it is easily removed by doors at front. The doors, D, are placed so as to allow of a brush being passed through, to sweep away any sooty deposit from the boiler shell, should any such deposit take place.

It is claimed as the result of experiments made with this draught, that results varying from 78 to 82 per cent. of efficiency, and a coal consumption of from 30 to 35 lbs. per square foot of grate, have been obtained. The induced draught apparatus is driven by Ernest Scott & Mountain electric motors, each developing 20 brake horse-power.

The surface condenser, which is illustrated, has been manufactured by Messrs. Cole, Marchent & Morley, of Bradford, and is large enough to deal with 30,000 lbs. of steam per hour at 200° Faht.; it consists of about 2,500 square feet of solid drawn brass tubing, secured into brass tube plates with screwed ferrules; on each end of the condenser doors are provided to give access to the tubes for cleaning out, &c. To the side of the condenser two single acting air pumps are bolted, each being 12 inches diameter and 9 inches stroke. These pumps draw the condensed water from the condenser, and deliver it into a storage cistern some distance above their own level; they are driven by a Rosling and Appleby electric motor and spur gearing, the former being coupled direct to the main switchboard close by; the pump resistances are arranged with seven notches, so that the speed and power of the motor can be varied to suit the requirements of the load on the station.

The centrifugal circulating pumps for the same plant will deliver together 2,500 gallons per minute through the condenser; the pumps draw their water from a well close to the engine house, which well is connected by means of a large pipe to the cooling reservoirs, the delivery from the pumps is taken through the condenser and delivered by 12-inch pipes outside the engine house, from which place the water runs in open troughs back into the cooling reservoirs. Both the pumps are driven by one electric motor, made by Messrs. Rosling & Appleby, off the 250-volt circuit, and are coupled to either end of the motor shaft, one by means of a friction clutch. A resistance is placed in the shunt circuit of the motor, so that the speeds can be slightly varied. The arrangement thus allows of considerable adjustment, as either one or two pumps can be run, each or both, at varying speeds.

In order to avoid overstraining the motor, in case the attendant should throw the friction clutch into gear too quickly, and thus endeavour to put a large volume of water into quicker motion too suddenly, it is compound-wound in such a way that if the load is increased the speed drops, thus enabling the motor to take up its work quickly, and without over-straining.

On testing the plant under load, it was found that the light load required about 20 horse-power for the whole plant, and when doing its full capacity the power was increased to about 30 horse-power, and as the condenser is capable of dealing with steam from about 2,000 horse-power, this small load amounts to 1½ per cwt. of the engine, and would effect a saving of not less than 25 per cent. of coal.

The advantages of electrically-driven plant for the foregoing purposes are considerable, for it is possible to use power from the economical plant of the station. No steam pipes are required, with their attendant leakages, drains, steam traps, packed glands, lubricators, &c.

The main steam pipes consist of one horizontal ring of 10-inch bore lap-welded steel tubes, having cast-iron tee-pieces for derivation of boiler and engine branch pipes. The branch pipes are of solid-drawn copper.

The main exhaust pipes consist of 20 inch bore cast-iron pipes, made in sections, with inlets formed for connecting the respecting branch pipes. The branch pipes are from 14 inch to 18 inches bore.

The switchboard, which has been made by Messrs. G. A. Steinthal, above the platform floor consists of ten slate panels 1 foot 6 inches × 6 feet 4 inches long × 1½ inches thick, and two slate panels 4 feet wide × 6 feet 4 inches long × 1½ inches thick. The switchboard below platform floor consists of ten slate panels 1 foot 6 inches wide × 3 feet long × 1½ inches thick. The ampere gauges and electrostatic voltmeters on the panels above the platform are Lord Kelvin's instruments.

Thomson-Houston recording watt meters are fixed on the panels below the platform floor, and register the output of power direct from the Station.

The cables, which are of the British Insulated Wire Company's manufacture, consist of five lines, each 1,030 yards in length, of 1·5 square inch sectional area, high conductivity copper. The insulation material used consists of high-class hemp paper, specially manufactured, and impregnated with resin oil. The insulation is protected with a solid lead tube of a radial thickness of $\frac{1}{8}$th of an inch. A further protection consists of two ribbons of mild sheet steel, wound one over the other so that the convolutions of the upper layer overlap those portions of the cable left unprotected by the lower layer.

One thousand and fifty yards of three-core pilot wire is also laid with the above cable, to which the registering instruments on the switchboard are connected.

The estimated cost of the new electric works is as follows:—

1.	Buildings	£11,500
2.	Condensing reservoir	220
3.	Machinery, including—	
	Engines (two 600 I.H.P.)	4,400
	Dynamos (two 600 C.H.P.)	2,650
	Feed pump	175
	Boilers (two)	3,000
	Weighing machine	100
4.	Steam pipes, valves, &c.	1,135
5.	Condensing plant	1,500
6.	Electric lighting of building	50
7.	Batteries	750
8.	New switchboard	500
9.	Cable (for extensions)	4,000
10.	Travelling crane	320
11.	Cables (for change to 3-wire system) ...	9,700
		£40,000

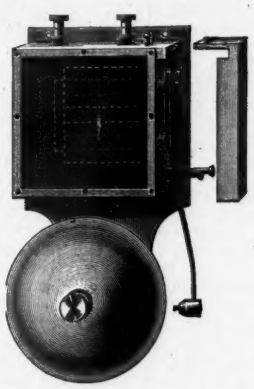
A Model Saxon Shop.—In a descriptive article in *Machinery* of a workshop in Saxony, Mr. Grimshaw says he found 700 men doing their best to keep up with orders and not succeeding. The shops referred to are those of J. E. Reinecker, of Chemnitz, which have doubled in size in the past three years. The buildings are of the weaving shed type, and contain many hundred machine tools arranged systematically, and with plenty of room all round. They are electrically driven. The shops are engaged in the machine tool trade, and the manufacture includes milling cutters, taps and dies reamers, gauges, drills. Where possible, the motor frame is part of the machine tool it is to drive, but there is also some driving from countershafts, which are electrically driven. Some idea of the work done here is to be obtained from the statement that one of the large planers had its rays scraped so carefully, that planer rays planed on this machine require no scraping, but are set to work unscraped. The shops are well supplied with American tools, which have no doubt found their way there by reason of cheapness, and will continue to do so while English trade union men refuse a fair day's work for a day's good pay. The main shop measures 361 feet × 197 feet, the smithy 121 feet × 39 feet, and the hardening room 121 feet × 33 feet. There are 270 lathes, 80 milling machines, 30 boring machines, 50 planers, and 20 miscellaneous tools. The engine is of 150 H.P., of which 100 H.P. goes off in rope-driving, and the rest electrically, and a second engine of 250 H.P. drives a dynamo for power and lighting purposes. The description of the power is a little involved and misty, and we simply state it as given. The proprietor is cited as a curious sort of German, for he permits no beer on the premises at any time, but a coffee apparatus furnishes coffee to the men at cost, which is all very well, we should say, to those who like coffee, but what about those who have a coffee heart! Several illustrations show what manner of shops these are, and there is certainly nothing to find much fault with, and if there are many like them, it would be wisdom to send a few workmen to see them. Might we not suggest that the Employers' Federation get up an annual series of trips for representative men, who would see how trade may be fostered by working hard, and what a poor thing is the policy of shirking, which has become the vogue amongst English workmen.

BUSINESS NOTICES, &c.

(*Continued from page 760.*)

The Illinois Steel Company.—From this company, of Chicago, we have received a very neat booklet of 40 odd pages, which describes the company's steel works, and the plant and operations at same. Some excellent photos show the various buildings, with the furnaces, mills, and other machinery at work.

Water-Tight Bell.—We have received from Messrs. Dixon, Clayton & Co., a sample of their water-tight bell and ringing key, both of which are substantially constructed and well finished. The bell consists of an electro-magnet in a hermetically-sealed case, through which the poles protrude, the armature being protected against mechanical injury by a suitable covering. The vibration is



effected in the ringing key, with the usual contact breaker. By this arrangement not only is the bell free from liability to derangement short of actual smashing up, but the user can hear whether or not the circuit is complete and the bell ringing. Although intended to be used where there is no risk of damp or injury, the key is constructed on the same lines as the bell. It seems to us specially suitable for colliery or railway work, or when there is excessive dampness from steam or other causes; the bell still acts when immersed in water.

ELECTRIC LIGHTING NOTES.

Aldershot.—Mr. Reginald P. Wilson has been appointed by the District Council to advise them with regard to the question of electric lighting. Application is now being made for a provisional order.

Alyth.—A private installation has been put down for lighting the premises of Mr. Silver, clothier, of Toutie Street. A 5 H.P. gas engine drives a dynamo which furnishes current for the 60 16-C.P. lamps. Messrs. James Maxwell & Son carried out the work.

Argentine.—Messrs. Delaunay, Belleville & Co., of St. Denis, France, have just secured a contract for a number of Belleville boilers for a new central electric lighting station at Buenos Ayres.

Barking.—The District Council had before it some days ago a tabulated list of tenders for the electric lighting plant. The Electric Light Committee recommended the acceptance of the following:

Section A.—Plant, W. H. Allen & Co.	£2,885.
„ B.—Battery, Chloride Electrical Storage Syndicate ..	£600.
„ G.—Arc Lamps, Lucy & Co...	£399.

The tenders for Section C (switchboard) and E and F (mains) had yet to be considered, and for D (crane) new tenders had to be obtained. The engineer's estimate was £5,200 for A, B, C and D; £4,500 for mains (E and F) and £360 for arc lamps (G). It was complained by several councillors that the Sunderland Forge Company's tender was £600 below that suggested for acceptance for "A." Eventually the tenders were referred back to the committee.

Bath.—Some alterations are to be made in the street lighting lamps. A number of the standards are to be removed from narrow thoroughfares and brackets substituted; in other places the positions of the posts are being altered.

Bermondsey.—The Vestry in applying for an electric lighting order will state the probable cost of the installation for lighting the compulsory area suggested by Mr. Manville, at £16,000.

Bethnal Green.—A report was brought before the Guardians the other day by the Finance Committee on the relative cost of gas and electricity for lighting the new infirmary. The architect had estimated the cost at £1,035 per annum, if the current were generated from their own plant, but £1,593 odd if taken from another source. The necessary installation would cost about £3,850. For gas lighting the cost at 3s. per 1,000 would be £1,275 per annum, and the cost of laying in the gas fittings would be about £1,775.

Blockley.—There was a parish meeting held some days ago to consider the lighting question, and it was decided to canvass for contributions, and to receive tenders for oil or electric lighting.

Bray.—The Commissioners are reducing the price of electric current for private lighting from 8d. per unit to 6d., the reduction to take effect from January 1st next. There is also to be an all-night supply.

Bridgend.—At last week's council meeting it was decided to apply for a provisional order.

Bromley (Kent).—The Bromley Electric Light Company, which was recently formed for establishing electric light works in this district, has decided to adopt a differential scale of charges, and 7d. per unit will be the maximum demand, and 4d. per unit afterwards.

Buxton.—The Council last week decided to take immediate steps to establish electricity works under the existing provisional order.

Darlington.—On 19th inst. the Town Council instructed the Town Clerk to make application to the Board of Trade for a provisional order.

Dewsbury.—Arc lamps are being placed in a number of the leading thoroughfares, central positions having been chosen.

Dingwall and Strathpeffer.—For the electric lighting company which it is proposed to form, it is suggested that the capital be fixed at £12,000, but meantime only £10,000 will be needed.

Douglas.—It is stated that as the negotiations between Douglas Corporation and the Isle of Man Tramways and Electric Power Company, Limited, for lighting the principal thoroughfares of the town by electricity have ended in failure, an electric lighting company is being formed for supplying a portion of the town with electric light.

Dublin.—We cull the following from the *Freeman's Journal*:—"The electric lighting muddle appears to be getting thicker than ever. The Local Government Board have refused to sanction the loan of £20,000 needed to restore the present system to efficiency; and it is rumoured that the expert who has reported upon it says that the present station can never be made to pay. If that is so, it is a curious comment on the assertion of the Chairman of the Electric Lighting Committee, that the concern was already a thriving and prosperous one."

Several tenders are said to have been deposited with the Board of Works for the contract for the electric lighting of the various Government offices in Dublin.

Erith.—The Erith District Council has appointed a committee to consider the matter of electric lighting and decide whether to apply for powers.

Hanley.—At the inquiry into the circumstances of the death of an engine man at the electricity works, to which we referred last week, a verdict of "accidental death" was returned. The medical evidence showed that death was caused by the injuries to the head, but on the left arm and hand there was a superficial burn such as might have been caused by electricity.

Hastings.—At the last meeting of the Town Council the Lighting Committee reported that they had authorised the town clerk to give the usual Parliamentary notice of the intention of the Corporation, in accordance with their contract with the Hastings Electric Light Company for the purchase of the undertaking, to apply to the Board of Trade for the necessary provisional order. Replying to protests that were raised, the town clerk stated that the provisional contract had been entered into, and it was possible that the Council might become involved in legal proceedings if they withdrew. Eventually the report was adopted.

High Wycombe.—The Electric Lighting Committee reports to the Council that the provisional order has been transferred to the company as arranged. The committee is considering whether to appoint an electrical engineer during the construction of the works.

Hospital Lighting.—The Northern Hospital Committee reminded the Metropolitan Asylums Board on Saturday that in June last they reported on the subject of the heavy expenditure on gas for this hospital. In their statement just presented, the committee thought that electric lighting should be substituted for the present gas system, as they considered it would be more economical and greatly superior. They therefore recommended, and it was decided to engage Messrs. Burstall & Monkhouse, electrical engineers, to report upon the question giving full particulars of the system of lighting they consider most suitable, and estimates of the cost both of establishing and working such system.

Ilfracombe.—The Town Council will not support the proposed applications by companies for provisional orders, but will take the matter in hand themselves.

Lancaster.—There is a vacancy at the electricity works for a pupil. See our "Official Notices."

Leith.—The Electric Light Committee has approved the amended plans for electricity works at Junction Street. Buildings are to be erected large enough to contain sufficient plant to light the whole of the borough, but at present only a small portion of the plant is to be put down. Accommodation is made for the storage of about 2,500 tons of coal. The cost of the buildings, including the chimney, is to be about £10,000.

Liverpool.—The Lighting Committee has passed a resolution instructing the town clerk to include in the Parliamentary notices for their next Bill power for the Corporation to borrow, from time to time, such amounts as may be required for extension of the electric lighting works in the city, not exceeding in the whole £200,000.

Llandudno.—The District Council has appointed Mr. L. G. Trindle clerk of works and to supervise the construction of the electric light and destructor works. A draft scheme prepared by Mr. A. H. Preece setting forth the terms upon which the Council will supply current was approved.

Norden.—The District Council decided some days ago, after going into the question of gas *v.* electricity, to light the road from White Lion Inn to Red Lumb Road with electricity, if it can be done according to the estimate given. The necessary machinery will probably be placed in Mr. Cudworth's premises.

Partick.—The Commissioners will oppose the application of the Kelvinside Electricity Company for a provisional order.

Portsmouth.—It is stated that the Electric Lighting Committee have received a demand for income tax to be paid on the £4,320 realised last year. The demand is to be resisted on the ground that the money belonged to a body of small ratepayers, this principle applying in the case of the Co-operative Society, which did not pay income tax, as it belonged to small proprietors.

Provisional Orders.—The *London Gazette* of November 19th contains notices of the following applications for provisional orders:—Cardiff Corporation (tramways); Chelmsford District Council (electric lighting); Blackpool Corporation (various powers *re* electricity agreements and tramway lines); Marylebone Vestry (electric lighting); Royal Leamington Spa (application for electric lighting powers by the Midland Electric Light and Power Corporation); Hastings Corporation (electric lighting); Weston-super-Mare (application for electric lighting powers by the Weston-super-Mare Electric Light and Power Syndicate); Crewe (application for electric lighting powers for the Corporation); Lewes Corporation (electric lighting); Gravesend Corporation (electric lighting); Hartlepool Corporation (tramways); Dartford District Council (electric lighting); Aston Manor District Council (electric lighting); Batley Corporation (electric lighting).

The *London Gazette* for Tuesday, 23rd inst., has the following:—Lewisham electric lighting (powers to the Great Western Electric Light and Power Company); Great Northern and City Electric Railway extension and other powers; Chichester Corporation electric lighting; Folkestone electric tramways (powers to form a company for the purposes); London United Tramways Company (powers to construct new tramways and to use mechanical power); Woolwich and South-East London Tramways Company (powers to construct tramways in Woolwich and Plumstead); Ilford District Council (electric lighting); Portsmouth Corporation (tramway powers, and to use animal, electricity, or mechanical power thereon); Norwich Electric Tramways Company (electric tramway powers); Metropolitan Electric Supply Company, various powers; Blackpool and Fleetwood Tramway Company (tramway extensions); Chislehurst Electric Supply Company (electric lighting); General Power Distributing Company (powers to supply electricity within certain districts to which we referred in a "Note" last week); Prescott electric lighting (powers to the British Insulated Wire Company); Southend Gas Company (gas and electric lighting powers); Liverpool Corporation (tramways extensions); Burnley Corporation (tramways); Chelsea Electricity Supply Company (powers *re* electric lighting of St. Luke's Parish, Chelsea); Brighton (power to form a company for construction of underground railway); Central Electric Supply Company (powers *re* electricity supply for Marylebone); Birkdale District Council (electric lighting); Eastern Telegraph Company (powers *re* capital); St. Helen's Corporation (tramway powers); Whitechapel and Bow Railway (electric railway); Hornsey District Council (electric lighting); Paddington and Charing Cross (electric railway); City and Brixton Railway (electric); Manchester Carriage and Tramways Company (various provisions, including mechanical power).

Shrewsbury.—On Monday, the Town Council held a special meeting to consider electric lighting matters, and a resolution was passed applying for a provisional order. Councillor Deakin, who moved the resolution, said that he regretted to say that the Shrewsbury Electric Lighting Company were desirous of altering the terms on which the Council were to take over the undertaking of the company. The Council agreed to purchase the undertaking for £21,500, and were prepared to stand by that arrangement, but the company were now submitting additional terms, which had already been rejected by the Finance Committee. In addition to the purchase price mentioned, the company wanted the Corporation to pay a commission of 10 per cent. on all liabilities incurred from January 1st last until the completion of the purchase, or a sum not exceeding £500, as a fund to meet current expenses, such as officials' salaries, engineers' fees, and legal and other expenses; that in the event of the Corporation not becoming purchasers of the undertaking and the outlay having been incurred by the company to provide for street or the lighting of public buildings (of which expenditure due notice would be given to the Corporation), the Corporation should take current from the company in full value, equal to the payment of 10 per cent. on such outlay. He did not think it was right that after the Council had come to an arrangement with the company that the latter should endeavour to introduce fresh terms.

Rothesay.—There is a proposal on foot that the Town Council should apply for a provisional order. The proposed installation is expected to include the lighting of the pier and harbour, the Esplanade, and the shores from the Aquarium on one side to the Skeoch Wood on the other.

St. Just.—Mr. V. Corin who has been going into the question of the utilisation of water-power for electric lighting purposes, has reported adversely. For effective electric lighting water sufficient for 25 H.P. was necessary, but only 5⅔ H.P. appeared to be available. He suggested as an alternative, that petroleum engines be employed. The matter stands deferred.

Sunderland.—At last Saturday's meeting of the Municipal and County Engineers, at Sunderland, Mr. J. C. F. Snell, the Borough Electrical Engineer read a paper on the "Sunderland Electric Lighting." He stated that a system of arc lighting in the principal public streets is about to be inaugurated. The contract for lamps has been let to Messrs. Crompton & Co., and these will burn four in series across the outers of the low-tension three-wire system. The poles are being supplied by Mr. J. Spencer, and are of steel in two sections, the upper section tapering, and the poles being set in ornamental cast-iron bases. The reason for the adoption of steel poles is their possible requirement for the support of overhead wires for electrical traction. The lamps will be suspended from swan necks at a height of 21 feet from the ground, and will be placed about 60 yards apart. In two years the number of lamps connected has been more than quadrupled; so far, although a big profit has been made on the actual working of the station, there has been a charge on the rates in each of the two years, interest and sinking fund being included. But there is every probability of this charge being very much reduced during the current year as compared with last year, and of there being an actual surplus during the next year, after paying something like £2,400 for sick fund and interest on that year. Sunderland supplies current to its consumers at the cheapest rate in the three kingdoms (whether municipal or private company), the average price paid per unit during last year having been only 4·09d., and the next lowest having been Newcastle at 4·14d. The apparent anomaly of an increased charge on the rates during the second year is explained by the fact that the Corporation reduced their prices to consumers by one-sixth during that year, and also the interest and sinking fund on the major part of the extensions became payable before that plant was really earning revenue. A most gratifying increase in the motors connected to the mains has been obtained. In March, 1895, only 29½ H.P. was connected; at the present time there is 291⅔ H.P., or in a little over 18 months the motor H.P. connected has been multiplied by 10. These motors are used for various purposes, such as for lifts and hoists, chaff cutting and corn crushing, printing presses, for driving workshop tools, pumping, and even for revolving hair brushes. A very notable addition has been recently made in the excellent pumping plant of the Bridge Dockyard, belonging to Messrs. Robt. Thompson & Sons. The demand is increasing so rapidly that extra boilers and steam dynamos will be again required for next year. It is Mr. Snell's intention to advise the Council to adopt high speed engines with such fly-wheel effect as will enable them to be used equally for traction or lighting requirements, in view of the possible equipment of the tramways in the town for electric traction.

Torquay.—The Chairman of the Electricity Committee has been to Bedford to inspect the electricity works and the electric street lighting.

Wakefield.—The City Council is waiting for the two large engines to be delivered before they can put the works at Calder Vale into operation. Two temporary engines are understood to have been obtained to tide over the time of the engineering strike, and supply certain buildings.

Walsall.—The Board of Guardians is inquiring into the relative cost of gas and electricity.

Withington.—Several electrical matters were before a recent meeting of the District Council. A householder 20 yards outside the boundary of Manchester, and within the Withington district, wanted a supply of current, and his engineer asked the Withington Council whether it would consent to such supply being taken from Manchester. The Council will not consent, as they are considering the matter of supplying the district. A firm of electrical engineers want to put down a small station and supply current to a few consumers, but the Council will not agree to this.

Wolverhampton.—The new buildings of the Drug and Dispensing Stores in Berry Street have been lighted electrically. A Parker dynamo is driven by a Ransome, Sims and Jefferies engine, and supplies current for incandescent lighting inside, and arc lighting outside the premises.

Worcester.—The Council will spend £500 in the erection of a fish-pass at the Powick Weir, to comply with the demands of the Severn Fishing Board and the Board of Trade, in consequence of the Council having raised the crest of the weir some nine inches, with a view to obtaining a greater amount of water at the electricity generating station to work the turbines.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

Aberdeen.—The new Council appointed its Tramways Committee last week. As the municipalisation of the tramways is to be considered shortly, there was a long debate as to the appointment of this Committee.

Brighton.—At the last meeting of the Town Council, the General Purposes Committee reported that they had again considered the notice of an intended application to the Light Railway Commissioners for an order authorising light railways in the Borough of Brighton, the Urban District of Hove, and the parish of West Preston, in the Rural District of Steyning. Communications from the British Electric Traction Company, Limited, on the subject of the application, were also again submitted, and it was resolved:—"That, in the opinion of the Committee, the project is highly objectionable, that the same be strenuously opposed on behalf of the Corporation, and that the Town Clerk do take all necessary steps to that end." The Town Clerk reported to the Committee that notice had been published of an intended application to Parliament next Session for an Act to incorporate a company with power to construct underground railways in Brighton, and it was resolved that so soon as plans of the proposed undertaking were deposited, the Town Clerk submit the same to the Committee for their information, and that he also obtain copies of the Bill for the use of the Committee when the same has been deposited in Parliament. In the course of the discussion which took place, Councillor Fowler said he hoped that if the Council did not see its way clear to grant the right of running these cars to a company, something would be done by the Corporation in this direction in outlying districts. It would be of immense good if they could only get electric tramways running up Ditchling Road to Queen's Park Road, or over Dyke Road. While he believed that a light electric railway might be used to very great advantage, he had no desire to see it on the Front, or in congested thoroughfares like Western Road. Councillor Carden said that his own ward, which contained about 11,000 population, would be, almost without exception, in favour of electric tramways, and if they went to Lewes Road Ward, the people there would certainly be in favour of the means of communication with the centre of the town being improved. A service of electric cars up Dyke Road to the Porshall district would be a great boon, and he could not see how they could object to that. There was no doubt that electric railways were objectionable to carriage people, but the Corporation had to consider whether they would take into account the carriage people or the more numerous class that had to do without carriages. In fact, most of the carriage folk of Brighton lived at Hove. Probably the company, if allowed to come to Brighton, would lay wood paving between the rails. An electric tramway would be a considerable benefit and convenience to the inhabitants of the town, and would probably lead to their living more readily on the outskirts. He moved an amendment to the effect that the matter be referred back to the committee for further consideration. The amendment having been seconded, Alderman Sir Joseph Ewart said he did not believe they were opposed to electric cars at suitable places. He thought, considering the narrowness of a large number of their streets, that it would be an error to give power to any company to interfere with their roads. The Mayor urged that they ought not to betray their trust to the people of Brighton by giving up their roads to private speculators. Eventually the recommendation of the committee was adopted.

Bristol.—The Bristol Tramway Company directors have given the statutory notices to apply for Parliamentary powers to extend their system in Bristol, and to work both present and new lines by electricity. In the main, this is a reintroduction of their scheme of a year ago, the greater part of which was withdrawn because of the City Council fixing terms as to electrical supply and working, which the company declined to accept. The part of the 1896 Bill which was gone through with, the Council assenting, gave power for the extension of electrical traction on the north-east side of Bristol to Staple Hill, and this section has been recently completed and opened. In the present notices the company omit all proposals for tramways in Clifton, owing to the antagonism residents displayed to suggestions of this nature 12 months ago. New lines, and the lengthening of old ones in other parts of Bristol will, should the scheme become a fact, increase the company's service by between five and six route miles. Several sections of the new lines could not be made a practical success unless electricity is the motive power, gradients being very steep. The company include in their application to Parliament a request for sanction to secure the large water side premises, once used as Finzel's sugar factory, for a generating station. This property is close to the civic electrical works of the Council. What will be the attitude of the Council to the scheme remains to be seen; popular impression is, the company will endeavour to arrange terms with the city by paying a royalty or wayleave for the use of the roads. Reference is made above to the opening of the electrical tramway to Staple Hill. It may be merely a coincidence, but the general manager has just written to a local committee to state that railway fares will be at once considerably reduced between Bristol, Fishponds, Staple Hill, Mangotsfield, and Warmley, and also that greater travelling facilities will be given to workmen holding the cheap daily ticket. Electricity competes with the M. Railway trains to each of these stations.

Bournemouth and Pokesdown.—The Pokesdown District Council has approved of the scheme of the New General Traction Company, Limited. A notice of dissent was sent to the promoters of the other schemes.

Buenos Ayres.—We gather from the *Review of the River Plate* that the City Council has approved by a majority of three votes the application of the Buenos Ayres and Belgrano Tramway Company for leave to change its present system of horse traction for that of electricity, the concession to continue in perpetuity as at present, the systems to be employed being the trolley. This has given rise to opposition on account of the narrowness of some of the central streets through which the company lines pass, and it is thought probable that the mayor will veto the bill. Our contemporary thinks that the conduit system should be employed in all streets narrower than 20 metres.

Cardiff—Penarth.—The new Parliamentary Committee has resolved to oppose the above electric light railway.

Chesterfield.—The Corporation, on Monday, took over as a going concern the plant, &c., of the Chesterfield Tramways Company. It is expected that there will be considerable development in the hands of the municipality.

Cork Tramways.—These tramways are situated in the city of Cork, and consist of about 11 miles of track. The gauge is 3 feet, which is the same as that of other lines running out of the city. The rails will be about 83 lbs. per yard. The station buildings will comprise an engine room, boiler room, battery room, car shed, and repair shop, covering an area of about 12,000 square feet. The boiler room will contain three Babcock & Wilcox boilers, each of 2,531 square feet heating surface, and capable of evaporating 8,000 lbs. of water per hour. There will also be an auxiliary heater, combined hot well and filter tank, and a duplicate set of Edmiston filters. The chimney stack will be steel self-supporting, 7 feet internal diameter and 130 feet high. The engine room will contain three McIntosh & Seymour side crank tandem compound engines directly connected to 200 kw. generators, running at 150 revolutions per minute. The engines will be run condensing, two Wheeler, Admiralty type, standard surface condensers, each having a capacity of from 8 to 12,000 lbs. steam per hour, being located on the engine room floor. Compound feed water pumps will also be in the engine room. The condensing water will be taken from the river about 500 feet distant. The battery room will contain 256 Tudor cells, capable of discharging at 110 amperes for 7 hours. A booster of suitable capacity will also be supplied for regulating charge of cell, booster being located in the engine room. The switchboard will consist of a combination of lighting and railway panels, the same machines being interchangeable in railway and lighting service. The lighting distribution, using 220-volt lamps, will be on the three-wire system at 440 volts across the outers. The battery and regulators will be connected in the neutral, so as to take care of any balancing current. The day-load will be taken from the railway generators by a motor generator consisting of a motor and two generators 220 volts, on the same bed-plate. The generators also act as regulators when a single 440-volt generator is supplying the lighting current direct. There will be 18 top-seat cars (Brush Electrical Engineering Company's) seating 44 passengers, mounted upon single Peckham trucks, with double motor equipments and series parallel controllers. The line construction will consist of iron poles with brackets. Side brackets being used for single track, and double brackets when centre poles are used for double track. There will be 94 arc lamps mounted on the top of the poles, constant potential arc lamps being used, connected to the underground network of lighting mains. The railway feeders will be of standard Callender construction.

Ealing.—The London United Tramways, Limited, intends to apply for powers to construct a number of new tramways in connection with its existing lines. One of the proposed tramways is to extend from Kew Bridge to Hounslow, through Brentford High Street. Another line will branch off from Brentford through Boston Road to Hanwell Broadway, where it will join a third branch running through Ealing to Acton Hill. The motive power to be employed on these new London United lines "will be animal power and electrical power, to be applied by the overhead system or otherwise, or any other mechanical power." The Ealing District Council will oppose the Bill so far as it affects Ealing. The proposal for the construction of an electric "light railway" between Acton Hill and Hanwell Broadway has, it is said, been dropped.

Folkestone.—The promoters of the tramway scheme have asked whether the Council would assent or not to the application to the Light Railway Commissioners for an order authorising the construction of light railways in Folkestone, Sandgate, Cheriton, and Hythe. A reply was deferred pending inspection of plans.

Glasgow.—Mr. A. E. C. Rossignol has been appointed electrical assistant to Mr. Clarke, the tramways engineer, at a salary of £250 per annum. It is expected that the Springburn electric tramways will be in operation by next May.

The Corporation had a long discussion last week regarding the cars which are proposed for the electric tramways. Some speakers objected to their being of the single deck type, and others complained of the door being at the middle of the car instead of the end. The Tramway Committee's minutes were, however, confirmed, and the suggested car will be tried.

Kidderminster.—The contractor broke ground last week, in Oxford Street, in connection with the work of laying that section of the electric tramline. The work at the generating station is well advanced, and it is expected that the line will be ready for traffic in the early months next year.

Liverpool.—At the meeting of the Tramways Committee last week, Sir Arthur Forwood, M.P., was re-elected chairman. Previous to the general meeting, a special meeting was held to consider the pattern of the rails for the experimental electric line from St.

George's Church to the Dingle. It was decided to order for part of the line a girder rail of English manufacture, 7 inches deep; also to obtain, by way of test, a number of American girder rails, 9 inches deep, and, further, to lay another portion of the line with rails of the pattern designed by Mr. G. F. Deacon, C.E., and now in use in the tram lines in Lord Street. The latter rails are laid on creosoted wooden sleepers. Details as to the connection of the rails for the purposes of the return current were discussed, and it was decided to establish the connection by means of copper wires through the fish-plates.

London County Council and Tramways.—The L.C.C. is to apply during the next Session for a Bill authorising it to construct and work a tramway over Westminster Bridge, and to make junctions with the existing lines of the London Tramways Company, Limited, and of the South London Tramways Company. The Bill will also seek powers to enter into certain agreements with the Tramway Companies with respect to maintenance and working. The Council is also to promote a Bill for the construction of tramways in Holborn, Clerkenwell, and Islington. All these lines will be of the standard guage, and it appears that at present it is not proposed to employ mechanical power. We think there are few places in this country where new tramways are being laid to be worked on the horse system. The L.C.C. condemns the trolley practically unheard, while enterprising provincial districts give it a trial.

Llandudno.—The District Council has instructed the Surveyor, Mr. Stephenson, to take steps for the preparation of plans, sections, and estimates for the proposed tramways. The lines would commence in Bodafon Road, and extend to the West Parade.

Norwich.—The Council had before it, the other day, a report of the Tramways Committee, as to the tramways proposed to be constructed under the Norwich Electric Tramways Order, 1897.

Nottingham.—Messrs. Mellors, Basden & Mellors, solicitors, of Nottingham, have submitted a scheme for the working of the tramways, on behalf of a syndicate. The offer, which is based upon the adoption by the Corporation of a combined system of cable and electric haulage for the tramways, is as follows:—The cable system being adopted for the city routes as being the best suited to give a quick and reliable service under all conditions of weather upon the numerous long and steep inclines, and to cope successfully with the frequent rushes of traffic. The trolley system of electric traction being adopted for the suburban routes, where the gradients are lighter, the service not so frequent, and the speed higher. Subject to the Corporation granting a lease for not less than 21 years for the use of the routes—including the reconstructed existing routes—this syndicate is prepared to form a company to be called the Nottingham City Tramway Company, Limited, to equip with cars, and work the cable and electric lines. To give a service varying from 5 to 10 minutes on the town and suburban routes, and a 2½ minutes' service from the Gregory Boulevard, *viâ* the Market Place, to Trent Bridge. To charge penny fares for the various stages of about 1 mile in length. To run a service of workmen's cars in the early morning and evening. To give the employés short hours of work, as at present. To pay the Corporation 7½ per cent. per annum for the use of the roads constructed and fitted with necessary power and road equipment, including rent, interest, and sinking fund upon the cost of construction of the routes up to but not exceeding the sum of £250,000, which sum we estimate they will cost, including the amount paid to the old company, and the loss on the realisation of the old company's material. To pay to the Corporation annually a proportion of the surplus net profits, after providing for the necessary reserves and sinking fund, and the payment of 6 per cent. dividend upon the entire share capital of the operating company. The auditor of the Nottingham Corporation to be entitled, after the operating company's books have been audited by the company's auditor, to inspect, take copies of the balance-sheets, and generally satisfy himself of the accuracy of the accounts. To deposit with the Corporation's bankers, under the control of the Corporation, the sum of £10,000 during the term of the lease. The interest derivable from such deposit to be paid to the credit of the operating company. The 7½ per cent. offered will not only pay the interest upon and redeem the capital expended by the Corporation in 30 years, but will leave a considerable sum to be applied towards the reduction of the rates. As the conversion of the existing routes could be proceeded with while powers to construct the new routes were being obtained, the town would be in possession of a complete system of tramways in a very short time, without risk, and without waiting the result of any experiments. The cable routes would be:—From Basford to Market Place, from Market Place to Trent Bridge, from Market Place, *viâ* Market Street, Parliament Street, Milton Street, Melbourne Street, and the Woodborough Road. From Lower Parliament Street and *viâ* a new street to St. Ann's Well Road. And the electric routes would be:—From Basford to Bulwell, from St. Peter's Church *viâ* Lenton Boulevard to the Ilkeston Road, from opposite the Bluecoat School *viâ* Mansfield Road to Winchester Street.—We understand that the Corporation has declined the above offer.

Spain.—The whole of the tramways in the town of San Sebastian are now operated electrically, the last section having just been completed and opened for traffic. The plant at the central station comprises three boilers, three steam engines, and three dynamos. The boilers, which are of the horizontal tubular type, intended for a pressure of 125 lbs. per square inch, were supplied by Messrs. Escher, Wyss & Co., of Zurich. This firm also supplied the three engines, which are of the horizontal type, and are each of 150 H.P. The dynamos are of the six-pole continuous current type, and were supplied by the Compagnie de l'Industrie Electrique, of Geneva.

The "Underground."—Addressing a meeting at Radcliffe last week on the subject of "Electricity," Colonel Mellor, M.P., deputy-chairman of the Metropolitan Railway Company, said they were hoping soon to run their trains by electricity. The company had only been too ready to welcome any scientist who would run their trains by electricity and do away with the locomotives, and he believed they were now within measurable distance of accomplishing their purpose, and, if so, a great advantage would undoubtedly be conferred on London.

Underground Electric Railways.—Among the new schemes for which Parliamentary powers will be asked next Session are the following electric railways:—Waterloo and New Cross, Waterloo and Paddington, and an extension of the City and South London line to Brixton Hill.

TELEGRAPH AND TELEPHONE NOTES.

Seismograms and Telegrams.—Prof. Milne lectured at the Camera Club at the end of last week on "Seismograms and Telegrams." He commenced by pointing out that in the instruments which are used for recording earthquake movements the necessary records are obtained by photographic methods on bromide paper. In this connection Prof. Milne had but little to say about the telegram ordinary, beyond pointing out that the difference between it and a seismogram was, that while the latter was the story of an earthquake told by itself, the telegram told it later in a more or less modified form. The seismogram was ahead of ordinary telegrams, for it could give information from anywhere in about 16 minutes. He could now give them the dates of some earthquakes which would be verified by-and-by when the telegrams came. There was one which, he judged from the nature of the disturbance, had taken place in Borneo. On August 4th there was one in Japan, but they only received a seismogram about that because they never sent telegrams about earthquakes in Japan unless about 300 people were killed. Generally speaking they could tell how far away the place was at which the disturbance took place, but not the place itself, though it was possible to judge approximately. The instruments he used in the Isle of Wight for recording distance earthquakes were not sensitive to anything rapid, and very different from what he would use near the scene of the disturbance; 75 per cent. of earthquakes came from under water in the neighbourhood of coasts. They were also frequent where the land for a great distance sloped down steeply to the sea, and in mountainous regions. Prof. Milne illustrated his lecture, says a daily paper, by a number of lantern slides, which dealt mainly with the effects of earthquakes in Japan, and the results of experience gained in consequence of a systematic observation of their movements.

Telegraphic Interruptions and Repairs:—

Cables.	Down.	Repaired.
Brest-St. Pierre (Anglo, 1869)	April 6th, 1893 ...	...
West Indies—		
St. Croix-Trinidad ...	Nov. 30th, 1896 ...	...
Paramaribo-Cayenne ...	Oct. 25th, 1897 ...	...
Amazon Company's cable—		
Parintins-Itacatiara ...	May 5th, 1896 ...	...
Obidos-Parintins ...	Dec. 7th, 1896 ...	...
Cable beyond Santarem ...	Oct. 23rd, 1897 ...	Nov. 19th, 1897.
Otranto-Vallona	Oct. 11th, 1897 ...	...
Cadiz-Teneriffe	Oct. 26th, 1897 ...	Nov. 20th, 1897.
San-Thomé-Loanda	Nov. 8th, 1897 ...	...
Pernambuco-Ceara	Nov. 22nd, 1897 ...	...
Landlines.		
Trans-Continental line beyond Masol	March 12th, 1896 ...	...
Carthagena - Barranquilla (Columbia)	July 4th, 1896 ...	...

The Franco-American Cable.—The *Pall Mall Gazette* stated some days ago that the s.s. *Silvertown*, which left Calais in August last with the deep-sea portion of the new Franco-American cable, has returned to port, having been unsuccessful in her efforts to recover the end that was buoyed in deep water. Hopes are entertained that she will be more successful next summer.

The Amazon Cable.—The Amazon Telegraph Company, Limited, notifies the restoration of communication with Manaos.

CONTRACTS OPEN AND CLOSED.

OPEN.

Barrow-in-Furness.—December 15th. The Corporation wants tenders for the supply and erection of boilers, pumps, economiser, &c., engines, generators, switchboards, accumulators, high and low tension cables, conduits, &c. See our "Official Notices" for full particulars. Consulting engineers, Messrs. Kincaid, Waller & Manville.

Canterbury.—The Corporation Electric Lighting Committee is inviting tenders for the supply of Lancashire boilers, and boiler house plant, steam dynamos, condensers, &c., for the engine house, overhead travelling crane, switchboard, accumulators, mains, arc and incandescent lamps, meters, &c. Consulting engineer, Mr. Robert Hammond. See our "Official Notices" last week.

Dundee.—December 3rd. The Gas Commissioners want tenders for an economiser for the electricity works. Electrical engineer, Mr. W. H. Tittensor. See our "Official Notices" last week.

France.—November 30th. Tenders are being invited by the French Post and Telegraph Authorities for the supply of a quantity of telegraphic apparatus of the Baudot type. Tenders to be addressed to the Sous-Secretariat d'Etat des Postes et des Telegraphes, 103, Rue de Grenelle, Paris.

Italy.—December 30th. Tenders are being invited by the Municipal Authorities of Catanzara, for the construction of a tramway between the centre of the town and the railway station, to be operated either by electricity, steam or cable.

Leicester.—January 31st. The Leicester Corporation invites designs and tender for motor vehicles for the collection of house refuse. Specifications and particulars, with drawings, to be sent to the Chairman of the Sanitary Committee, to the office of Mr. E. Geo. Mawbey, C.E., borough engineer, Town Hall, Leicester.

Londonderry.—December 9th. The Corporation want tenders for the supply of carbons for one year. Electrical engineer, Mr. J. Christie. See our "Official Notices" last week.

London.—December 2nd. The Metropolitan Asylums Board want tenders for alterations and additions to the electric fire alarm system at the South Eastern Fever Hospital. See our "Official Notices" last week.

Singapore.—December 31st. The Municipal Commissioners are inviting tenders for the lighting of street lamps for a period of five years. Particulars from Mr. C. C. Lindsay, 167, St. Vincent Street, Glasgow, or the secretary to the Municipal Council.

Warrington.—December 3rd. The Cheshire Lines Committee are inviting tenders for the supply of stores and materials for the year 1898. There are nineteen items, No. 6 being for telegraph materials, instruments, wire, &c. Particulars from Mr. S. Saxton Barton, storekeeper, Cheshire Lines, Warrington.

CLOSED.

Aberdeen.—The contract for the electric wiring and fitting at the new police workshops and courtyard has been given to Messrs. Shirras, Laing & Co., at £232 odd, this being the lowest tender.

Germany.—The contract for the erection and equipment of the power station in connection with the projected electric tramways in the town of Cassel has been placed with Messrs. Schuckert & Co., of Nuremberg.

FORTHCOMING EVENTS.

1897.

Friday, November 26th, at 5 p.m.—Physical Society of London, Burlington House. "Upon the Failure of German Silver and Platinoid Wires," by Mr. Rollo Appleyard. Council Meeting at 4.15 p.m.
Electro-Harmonic Concert; Ladies' night.
Physical Society meeting.

Saturday, November 27th.—Sanitary Institute. Visit to the Shoreditch Vestry refuse destructor and electric light works under the guidance of Mr. C. N. Russell, the chief electrical engineer.

Monday, November 29th.—Yorkshire College Engineering Society, Leeds. Paper by Mr. Herbert Perkin on "The Engineering Features of the Sinking and Equipment of a Modern Colliery" (*illustrated*).
Society of Arts, at 8 o'clock. Cantor lecture. First of a series of three lectures on "Gutta Percha," by Dr. Eugene F. A. Obach, F.I.C., F.C.S., M.I.E.E. Synopsis of first lecture: *The Raw Material.*—The year 1847—Early history and the Society of Arts—General properties and distinction from Caoutchouc Botanical derivation and geographical distribution—Expeditions in search of gutta trees and experimental cultivation—Analysis of particular specimens and of various commercial brands—Exports from Singapore, imports into the United Kingdom and fluctuations of prices.
Cannon Street Hotel, at 3 o'clock. Extraordinary general meeting of Crompton & Co., Limited, to pass resolutions *re* reduction of capital. Preference shareholders' meeting at 3.30 p.m.

Tuesday, November 30th.—Royal Society. Anniversary meeting, 4; Annual dinner, Hôtel Métropole, 7.

Thursday, December 2nd, at 8 p.m.—Chemical Society, Burlington House. Ballot for the election of fellows. Paper, "On Collie's space-formula for Benzene," by F. E. Matthews, Ph.D.

Friday, December 3rd.—Institute of Marine Engineers. Annual conversazione at the Town Hall, Stratford.

Saturday, December 4th.—Salford Science Students' Association. Annual general meeting and soirée.

Monday, December 6th.—North East Coast Institution of Engineers and Shipbuilders, Sunderland. Paper by C. H. Innes on "The Theory of the Centrifugal Pump and Fan."

THE ANNUAL DINNER OF THE INSTITUTION OF ELECTRICAL ENGINEERS.

The annual dinner of the Institution of Electrical Engineers was held at the Hotel Cecil on Wednesday night, over 200 members and friends being present. As a gastronomical entertainment it was probably the most sumptuous of any that has been held during the past few years. Sir Henry Mance presided, and among the distinguished guests and members were the Marquis of Tweeddale, Sir J. Crichton Browne, F.R.S., Sir Albert Kaye Rollit, M.P., Sir Courtenay Boyle, Dr. Collins, the Chairman of the London County Council; Rev. Dr. A. Robertson, Principal of King's College; Lord Kelvin, Profs. Hughes, Ayrton, and Thompson, and Mr. C. E. Spagnoletti.

Prof. Ayrton in submitting the toast of the Scientific Societies, contrasted the different conditions of scientific research that prevailed 30 years ago with what they were today. In those days he was a pupil of Lord Kelvin, and he remembered that the laboratory in the old University buildings was little more than a cellar. He upheld the great claims of experimenting, and referring to the progress of America, said he considered it to be the electrical laboratory of the world.

Lord Kelvin, in responding on behalf of the Royal Society, found fault with the arrangement of toasts, because the one for which he was replying ought to include the Institution of Electrical Engineers, which was the most scientific of all the Societies. As the Society of Telegraph Engineers, it carried on work of the highest scientific character. The Royal Society was the parent of all the scientific societies, and had great reason to be proud of its offspring. It continued its useful work with unabated vigour, and to this day was doing the work of a scientific society as successfully as it ever did.

Sir Wolfe Barry, the President of the Civil Engineers, replied for the Institution of Civil Engineers, and mentioned that an important deputation had attended upon Lord Salisbury lately, and urged upon him to put science more at the disposal of the manufacturing community than it had been up to now. Lord Salisbury had received the deputation with great cordiality, and the result had been the appointment of the Committee for the various matters brought before him by the deputation.

Sir James Crichton Browne spoke of what the electrical engineers had accomplished; they had probably done more towards the consolidation of the Empire than any other profession. The other learned societies looked upon the Institution of Electrical Engineers with great friendliness and interest. As a physiologist, he had been often struck with the lucidity of lecturers upon electricity at the Royal Institution.

Prof. Silvanus Thompson, in giving the toast of the "Guests," referred especially to the important work that lay before the County Council in regard to electric traction.

Dr. Collins, chairman of the County Council, in replying, said that the County Council had sanctioned the loan of half a million of money for electric lighting purposes to local bodies, and it regarded the efforts of these local bodies without any jealousy, and viewed with cordial approval any such action by the Vestries or District Boards or other bodies, by whatever name they might be called. He remarked that the Council would have to make great demands on the ingenuity of electrical engineers whenever the question of tramway traction was brought forward, and to a Society of this kind it looked for advice and assistance.

Sir Courtenay Boyle, in proposing the toast "The Institution of Electrical Engineers," mentioned that the Board of Trade had already granted 256 provisional orders for electric lighting, and of these 200 were practically working. While only 133 miles of electric trams and railways were open in this country, in America there were 17,000, so that

in the matter of electric traction there was a great deal of work to be done.

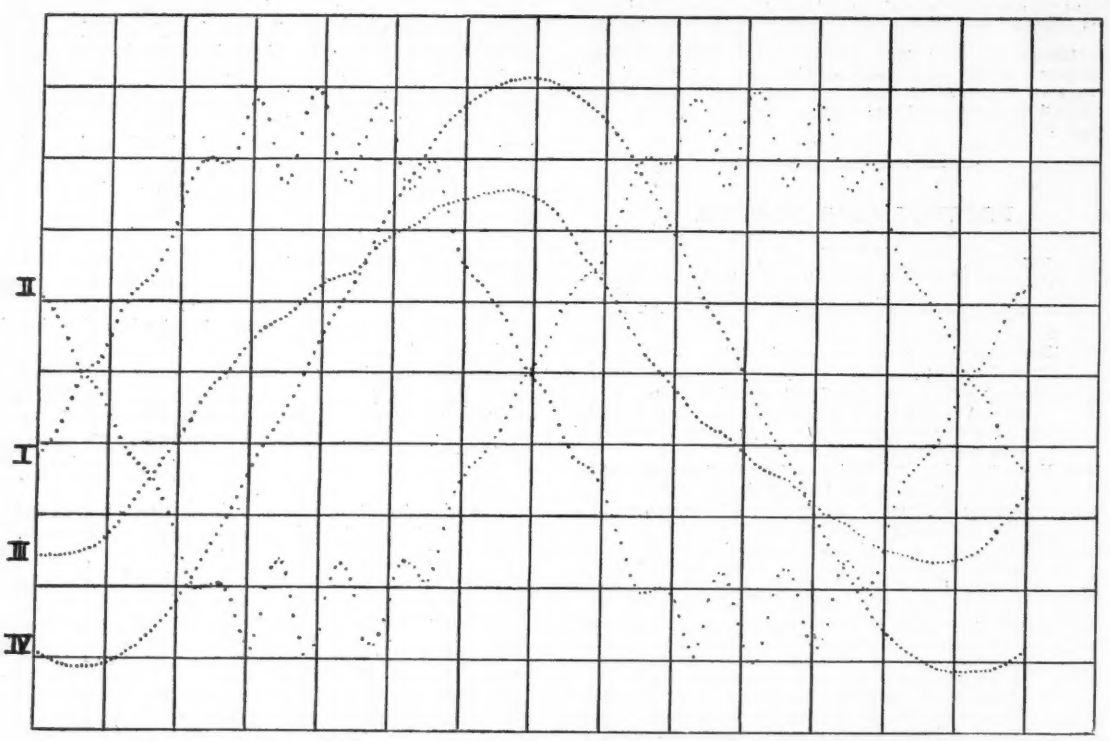
The President briefly replied, and gave a brief survey of the work that had been accomplished during the year.

Before concluding, the President referred to the approaching retirement of Mr. F. H. Webb, and mentioned his services in connection with the annual dinner. A very hearty vote of thanks was accorded to Mr. Webb, to which he briefly replied.

NOTES.

The Light Railway Question.—At the moment of going to press we learn that the question of promoting tramways under the Light Railways Act is now engaging the most serious attention of the Board of Trade. It will be remembered that in reality none of the orders granted by the Light Railway Commissioners has as yet been definitely sanctioned by the Board of Trade as supreme authority in the matter; and, from what we hear, the latter department is taking a somewhat rigid view of the circumstances and conditions. A deputation waited upon the Board the other day to set forth the claims of those who are engaged in the development of these lines, and we hope most sincerely that success will attend their efforts. It seems altogether too stringent a course to take for the Board of Trade to shut off all hope of obtaining tramway powers under any other regulations than those of the fatal Tramways' Act of 1870; and if developments are to be seen at all, help rather than hindrance should be given by those in authority.

Electric Curve Tracer.—The diagram shown herewith is taken from a transformer with Prof. Rosa's apparatus, which was dealt with at length on page 708 of our last issue, and has been kindly lent to us for reproduction by Messrs. Elliott Brothers, who are manufacturing the instruments for sale in England. The different curves in the original are drawn in dots of different coloured inks, which we are not able to imitate. The scale of the original is a little larger than our reproduction.



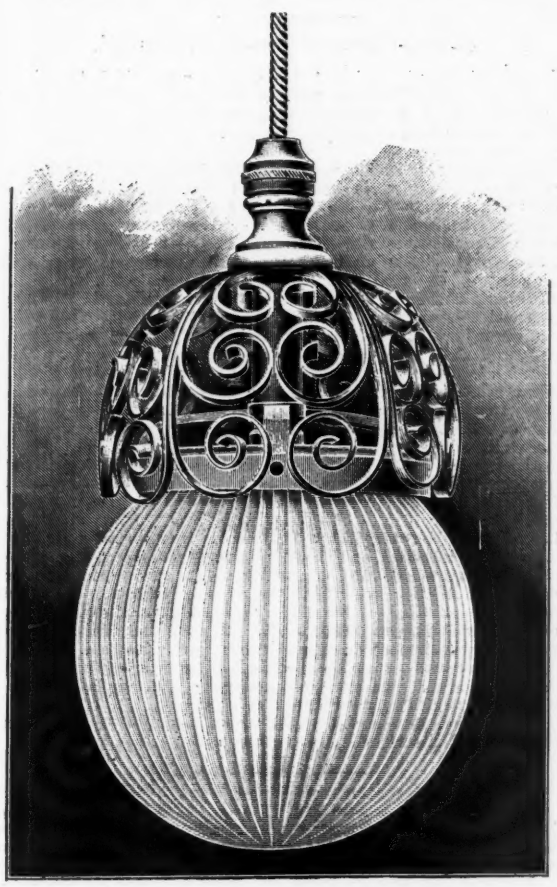
I. Primary E.M.F. 1" = 40 volts.
II. Secondary E.M.F. 1" = 80 volts.
III. Primary current 1" = 3 amperes (open secondary on transformer).
IV. Magnetic induction.

Lectures on Wireless Telegraphy.—We understand that Mr. Wm. Lynd, who is so well known as a popular lecturer on electrical subjects, is making arrangements to deliver a series of lectures on wireless telegraphy in different parts of the country. Mr. Lynd was for many years associated with telegraphy, both inland and submarine, and is the author of a work on Practical Telegraphy. In the lectures on wireless telegraphy, Mr. Lynd is receiving the assistance and co-operation of the Wireless Telegraph and Signal Company, and the addresses ought to be very interesting at the present juncture.

Obituary.—The death of Sir Henry Doulton, which occurred last Wednesday week, will be regretted by many men connected with the electrical industry. He was head of the well-known pottery firm of Doulton & Co., of Lambeth, having branches in various parts of this country. He has made "Doulton ware" famous all over the world. Apart from his sanitary ware, the name of Doulton is familiar to electrical men from the conduits, main boxes, &c., used in connection with a large number of electric lighting installations in this country. Honours in the form of medals and diplomas fell thick and fast to Sir Henry, and in 1887 he was knighted. Sir Henry was 77 years of age, and a cardiac seizure was the cause of death.

Steam Boilers.—We have received a very well got up catalogue of steam boilers from Messrs. Yates & Thom, the Blackburn boiler makers. It is exceedingly well printed, and beautifully illustrated, and as it has been written and compiled by Mr. W. H. Fowler, formerly of the Manchester Steam Users' Association, a well known expert in steam boilers, this is in itself a guarantee of excellence. Indeed, the catalogue is really a nice treatise on boilers, dealing with fuels, incrustation, efficiencies, evaporative tests, boiler setting, smoke prevention, as well as with various types of boilers and fittings and accessories. There are, in addition useful tables for steam users, forms of estimate, and specification. The catalogue is, in fact, in every sense fully abreast of the best American catalogues, and we are glad to know that it is at the same time none too good for the firm it represents, and whose work we have long known to be in the fore-front of excellence.

The Prism Globe.—We have pleasure in giving herewith an illustration of a new globe, now being introduced in this country, which has many distinctive features, both in the matter of appearance, and also of manufacture. The outer surface is quite plain, and therefore does not form too readily a shelf for the accumulation of dust, while the inside is ribbed with prisms, which diffuse the light in a beautiful and effective manner. From photometric measurements which have been made, it is claimed that loss of light with the new globe is practically *nil*. We saw this question of loss tested in a practical and homely way a few nights since, and can certainly state that it is scarcely, if at all, appreciable. The method of manufacture is interesting; a plunger with



prismatic surfaces is placed in molten glass, a cup-shaped vessel being the result, having prisms inside. This vessel is then placed inside a mould having a smooth inner surface, and the glass is then blown out to fill the mould, a globe resembling that illustrated being then produced. Such globes are remarkably effective for arc lamps and incandescent lighting, whether by electricity or gas. The Prism Globe Syndicate, Limited, with which are associated some well-known electrical engineers, has been formed to place these globes on the market, and offices have been acquired at Dashwood House, Old Broad Street, E.C.

Brussels Exhibition. — Messrs. Mercier's Patents, Limited, have been awarded the Diploma of Honour at the Brussels Exhibition, for their patent water-tight bells.

We understand that the Thomson recording wattmeter has obtained the Diploma of Honour at the Brussels Exhibition, being the only meter that has received such a distinction.

The Royal Society.—Among the papers down for reading yesterday afternoon were the following by Prof. J. C. Bose:—"On the Determination of the Indices of Refraction of Various Substances for the Electric Ray. II.—Index of Refraction of Glass," "On the Influence of the thickness of Air-space on Total Reflection of Electric Radiation."

A Good Record.—The *Pall Mall Gazette* correspondent at Cairo says that the Cairo electric tramways have, during their first year of operation, succeeded in killing or injuring 140 persons—generally natives—which doesn't say much for the tramways or for the natives. The present system is to be extended 16 miles. That is promising. Will there be a proportional increase in the number of accidents?

Conversazione.—The ninth annual conversazione of the Institute of Marine Engineers is to take place next Friday at the Town Hall, Stratford. Tea is to be followed by a very good programme of musical items. Mr. J. F. Flannery, M.P., &c., and will deliver the Presidential Address on "Some Successive Steps in the past Progress of Marine Engineering: its Existing Condition: Some Possibilities of the Future," and a ball will bring the proceedings to a conclusion.

Birkbeck Science Society.—A Science Society has been formed in connection with the Birkbeck Institution for the reading and discussion of papers on scientific and philosophical subjects. On Saturday last the first meeting was held, a large number of past and present students being present.

Green's Economiser.—We have received an illustrated catalogue of the Green Fuel Economiser, an apparatus still too rarely used in the South of England, but which is rightly claimed to reduce coal bills some 15 to 25 per cent., as well as serving to prolong the life of boilers, and to increase their steaming capacity. The catalogue contains numerous illustrations of the details of the apparatus, a custom which has been derived from American catalogues; indeed, this catalogue is an example of the improved information of the kind we have long been urging on English manufacturers, and in which we have all been so far behind the Americans. We are glad to see that Messrs. Green now cast their pipes vertically—a precaution necessary in these days of high pressure. We are pleased also to note the adoption of the sectional feed, first, we believe, advocated by ourselves. Numerous plates, showing arrangements of economisers to various classes of boilers, are placed at the end of the book, and there are also a useful table of percentage of saving, due to hot feeds, and some tabulated results of tests and other figures useful to the steam user.

Glasgow Appointment.—The seven gentlemen selected from among the 34 applicants for the post of electrical engineer were to appear before the Electricity Committee on Tuesday. Four names were added to the list of seven, and the whole eleven were referred back to the Sub-committee to be seen personally, and six selected for the Committee's final decision.

London Electric Omnibus Company.—According to the *Financial News* of Wednesday, Mr. William Marshall, the late deputy-chairman of the company, has sent the following "private and confidential" circular to the shareholders:—

Private and confidential.

November 22nd, 1897.

To the Shareholders of the London Electric Omnibus Company, Ltd.

Gentlemen,—As late deputy-chairman of the above company, I think it my duty to call your attention to the deplorable condition into which the company has fallen owing to the incompetency of the management.

Your company has now been formed nearly two years, and in the prospectus you were promised that 125 omnibuses would immediately be placed upon the streets. The company took over one 'bus from me, and although the directors, I am informed, have spent something like £25,000, beyond this there is not a single omnibus yet ready to start running.

I have myself invested about £28,000 in cash in the undertaking, and having influenced others in taking up shares, I am anxious that before it is too late the shareholders should take some steps to remedy the present unsatisfactory condition of the company.

Under these circumstances I request your kind attendance at a meeting of shareholders to be held at the Cannon Street Hotel, on Friday next, November 26th, at 3 o'clock, when you will have an opportunity of judging for yourselves as to the requirements necessary for the future.—I have the honour to be, gentlemen, your obedient servant,

WM. MARSHALL.

Care of Messrs. Haydon & Haydon,
16, Union Court, Old Broad Street, E.C.

The authorised capital of the Company is £250,000 in £1 shares, of which £130,000 has been subscribed and £105,000 called up.

Correspondence.—Owing to the crowded state of our columns this week, we are compelled to leave for our next issue a letter from Mr. H. L. P. Boot on "The Distribution of Electrical Energy," also several others.

CITY NOTES.

The Rand Central Ore Reduction Company.

The information which has been given in their report by the directors and the general manager of the Rand Central Ore Reduction Company on the electrolytic work performed in various gold mines is most encouraging, and show the progress made in the mining of gold, not only from the *tailings* but also from *slimes*, in spite of the enormous difficulties which had to be overcome.

The Siemens process has been the object of the formation of a limited liability company under the name of the "Gold Patents Company (Transvaal), Limited," with a capital of £125,000 in £1 shares, 100,000 of which have been issued, the Rand Central Ore Reduction Company receiving 50,000 shares for their holding in the Siemens and Halske joint account. The remaining 25,000 shares were speedily disposed of to parties holding large interests in the goldfields.

The policy of the Rand Central Ore Reduction Company in regard to the Siemens process, has been to make it a help and not a burden to the mining industry, and to further reduce the royalty as soon as the profits derived from this source enables the Gold Patents Company to pay a reasonable dividend on its capital stock. This royalty has already been reduced from 3 to 2 per cent., and they hope within a year to further reduce it to 1½ per cent.

Nothing could be more comforting for any person interested in the application of electricity to the gold mining industry than the statement made by Mr. Charles Butters, the managing director of the company. "The Siemens' process," he says, "has continued to be introduced with great activity during the past year. The Slimes plants now erected are using this process, and also several important tailings plants. Continued study in the construction of the Siemens boxes has been carried on, and now standard sizes of boxes are constructed. A plate 26 inches wide, 48 inches deep and $\frac{3}{16}$ths inch thick, is used, and for sand plants the boxes are 5 feet square and 32 feet long, and contain 156 iron anodes; whilst in the Slimes plants the boxes are 10 feet wide and 5 feet deep, and contain 24 iron anodes in each compartment, set 4½ inches apart, being 288 anodes in 12 compartments, and a current density of about ·04 amperes is used in the Slimes, and about ·06 in the Sand plants, per square foot. Both lead sheets cut into strips and lead shavings are used in various plants as cathodes. The working of the process is very simple, and is now well understood by those who are working it in the different cyanide and Slimes plants, and, as the simplicity and beauty of the process becomes better understood, its merits and usefulness will be still more appreciated."

The plants where the Siemens process is used are the following:—

	Plant.	Capacity in tons.
Gunsberg G.M. Co. ...	Tailings ...	3,700
Worcester	" ...	3,200
Van Ryn West	" ...	7,000
" Estates	" ...	7,000
Bonanza	... Tailings and Slimes ...	6,000
May Consolidated	Tailings ...	9,000
Balmoral	" ...	3,420
Glynn's Lydenburg ...	" ...	
Crown Reef	Slimes Plant ...	3,200
Knight's	Tailings ...	10,000
Simmer & Jack	" ...	8,000
Robinson	Slimes Plant ...	7,000
Central Works		6,000

The average monthly payment for royalty on the above basis of 2 per cent. equals £1,200.

Some plants are in course of erection in the following mines, and will be completed within a few months, when the Siemens process will be used:—Crown Deep, Rose Deep, Nourse Deep, Geldenhins Deep, Jumper's Deep, Village Main Reef, Transvaal Gold Estates, Treasury, Geldenhins Estate, Ferreira, Simmer and Jack, Lancaster. The Siemens process will also be worked by the following companies which contemplate erecting Slimes Plant: Witwater's Rand, New Heriot, Henry Nourse, City and Suburban Consolidated Main Reef, Sheba, Primrose.

In consequence of the large application of the Siemens process, by which gold is deposited on lead foil, the development of the smelting and refining department at the central works of the Rand Central Ore Reduction Company has been considerable. The company buys the lead bullion from the companies using the electrolytic system, and pays it directly upon the assay. It appears that the cupellation costs so little that the companies receive a sufficiently high price for their gold to induce them to sell their lead bullion to the Rand Central Company, rather than to ship their gold to London.

The following figures show the magnitude of this business of recovering the gold from the cathodes of the electrolytic tanks. The weight of lead bullion purchased by the Rand Central Ore Reduction Company from July, 1896, to June, 1897, was 2,409,130 ozs., yielding 31,588 ozs. gold bullion, which taken at 74s. per oz. = £116,875 12s. They cupelled also for other companies from July, 1896, to June, 1897, 1,580,772 ozs. of lead bullion, yielding 57,994 ozs. of gold bullion, which at 74s. per oz. = £214,577 16s.

The most interesting progress realised by Mr. Charles Butters, is the exploitation of old acid slimes and the recovery by the electrolytic process of the gold they contain. During the last seven months 33,732 tons of acid slimes of an average assay value of 3 dwts. 2 grs. have been treated, and in conclusion, the efficiency of electrolysis for mining gold will be better demonstrated by the following facts and figures:—

Total tons treated from 1892 to 1897 (inclusive)	1,073,425
Total ounces produced from 1893 to 1897 (inclusive)	25,238,072
Total value from 1893 to 1897	£979,850
Total gold handled by the Rand Central Ore Reduction Company from 1893 to 1897 (inclusive)	34,193,272 ozs.
Value	£1,311,302
Total gold handled for 1897	147,835
Value	£55,670

Electro-Chemical Company, Limited.

The annual general meeting of this company was held last week at St. Helens, Colonel Holland, C.B., in the chair. Mr. Martin Pirie (Alexander Pirie & Sons, papermakers, Aberdeen) and Mr. John Henry Walter (one of the proprietors of the London *Times*) were re-elected directors.

The Chairman, in his remarks, pointed out that though the commencement of their business had been impeded owing to the inefficiency of the first machinery supplied, they now had excellent engines and dynamos, and good workable plant, giving the best possible results. The machinery of five installations, amounting to 3,500 electrical horse-power, were all fixed and in position on the premises, and arrangements had been made for a further 1,600 electrical horse-power, making in all 5,100 electrical horse-power, or over 6,000 steam horse-power. They were now turning out in considerable quantities by their electrolytic process excellent 70 per cent. caustic soda and bleach ranging from 37·5 per cent. to 38 per cent., as well as the purest chlorate of potash, 99·8 per cent., all of the highest quality that could be made in the kingdom, at a cost for manufacture that even in these days of low market prices left them a fair margin for profit. Samples of these electrolytic products were produced, and carefully examined by those present. The chairman added that the business generally was being carried on profitably, the present weekly out-turn being about 70 tons of 70 per cent. caustic soda, 130 tons of 37 to 38 per cent. bleach, and 5 or 6 tons of exceptionally pure chlorate of potash. It was hoped, however, that these amounts would shortly be very considerably increased, and there was a ready sale for all their products at good prices. The company had sold its Japan patent for £6,000, half of which amount had already been received in cash; the balance was payable next January. They had also sold their French, Belgian, and Russian patents for £37,000, and arrangements were being made for the sale of other foreign patents. Several shareholders were present, all of whom had previous to the meeting inspected the buildings, plant, and machinery, and expressed themselves very pleased with everything they had seen.

The proceedings terminated with a cordial vote of thanks to the chairman and directors for their services during the past year.

The City of London Electric Lighting Company, Limited.—The engineer and manager informs us that the directors have decided to make a further issue of 10,000 ordinary shares at the price of £18 per £10 share, and to give to all holders of the existing 50,000 fully paid ordinary shares who were registered on the company's books on the 10th instant the right to apply for, and have allotted to them, the present issue of 10,000 shares in the proportion of one new share for every five old shares. Application forms and fractional certificates for such shares were on 19th inst. posted to the holders of the existing ordinary shares.

Brazilian Submarine Telegraph Company, Limited.—The directors have declared an interim dividend of 3s. per share, or at the rate of 6 per cent. per annum, free of income tax, for the quarter ended September 30th last, and payable on the 21st December. The transfer books of this company will be closed from 14th to 20th December, both days inclusive.

Stock Exchange Notices.—Applications have been made to the Stock Exchange Committee to appoint a special settling day in and to grant a quotation to—Amazon Telegraph Company, Limited—£125,000 5 per cent. debentures. New General Traction Company, Limited—20,000 6 per cent. cumulative preference shares, Nos. 34,001 to 54,000.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending November 21st, 1897, were £1,063; week ending November 22nd, 1896, £1,017; increase, £46; total receipts for half-year, 1897, £19,734; corresponding period, 1896, £19,842; decrease, £118.

The Liverpool Overhead Railway Company. The receipts for the week ending November 21st, 1897, amounted to £1,326; corresponding week last year, £1,183; increase, £143.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending November 19th, 1897, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £3,069.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1894.	1895.	1896.	Closing Quotation, Nov. 17th.	Closing Quotation, Nov. 24th.	Business done during week ended November 24th, 1897. Highest.	Lowest
149,900£	African Direct Teleg., Ltd., 4 % Deb.	100	4 %	4 %	...	101 —105	101 - 105	...	...
25,000	Amazon Telegraph, Limited, shares...	10	...	...	...	5½ — 6½	5½ — 6½	6	...
923,960£	Anglo-American Teleg., Ltd.	Stock	£2 2s.	£2 9s.	£2 13s.	58 — 60	58 — 60	58⅝	58
3,038,020£	Do. do. 6 % Pref.	Stock	£4 4s.	£4 18s.	£5 6s.	104 - 105	104 — 105	105	104½
3,038,920£	Do. do. Defd.	Stock	...	...	...	12½— 12⅝	12½— 12⅝	12 11/16	12⅝
130,000	Brazilian Submarine Teleg., Ltd.	10	7 %	7 %	...	16 — 16½	16 — 16½	16½	16¼
75,000£	Do. do. 5 %, Debs., 2nd series, 1926	100	5 %	5 %	...	114 —118	114 —118	...	...
44,000	Chili Telep., Ltd., Nos. 1 to 44,000	5	2½%	4 %	4 %	3½ — 3⅝	3½— 3⅝	...	...
10,000,000$	Commercial Cable Co.	$100	7 %	7 %	7 %	182 —187	182 —187	...	...
653,586£	Do. Do. Sterling 500 year 4% Deb. Stock Red.	Stock	...	...	...	105 —107	105 —107	106¼	106⅛
224,850	Consolidated Telep. Const. and Main., Ltd.	10/-	1½%	1½%	2 %	⅞ — 1	⅞ — 1	1 1/16	...
16,000	Cuba Teleg., Ltd.	10	8 %	8 %	8 %	8½ — 9½	8½ — 9½	9	...
6,000	Do. 10 % Pref.	10	10 %	10 %	10 %	18½ — 19½	18½ — 19½	...	...
12,931	Direct Spanish Teleg., Ltd.	5	4 %	4 %	4 %	4 — 5	4 — 5	...	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	10 %	10 %	10 — 11	10 — 11	10½	...
30,000£	Do. do. 4½ % Debs. Nos. 1 to 6,000 ...	50	4½%	4½%	4½%	103 —106%	103 —106 %	...	...
60,710	Direct United States Cable, Ltd.	20	2 %	2½%	2½%	10 — 10½	10 — 10½	10½	...
400,000	Eastern Teleg., Ltd., Nos. 1 to 400,000	10	6½%	6½%	6½%	17 — 17½	17 — 17½	17½	17
70,000	Do. 6 % Cum. Pref.	10	6 %	6	6%	18 — 19	18 — 19	18⅝	18½
89,900£	Do. 5 % Debs., repay. August, 1899	100	5 %	5 %	5%	101 —104	101 —104	...	..
1,302,615£	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	4 %	4%	131 —134	130 —133	133	131
250,000	Eastern Extension, Australasia and China Teleg., Ltd. ...	10	7 %	7 %	7%	18 — 18½	18¼ — 18⅝	18⅝	18 5/16
35,500£	Do. 5 % (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	5 %	5 %	5%	100 —104	100 —104	...	...
133,100£	Do. do. Bearer, 1,050—3,975 and 4,327—6,400	100	5 %	5 %	5%	101 —104	101 —104	...	...
320,000£	Do. 4 % Deb. Stock	Stock	4 %	4 %	4%	131 —134	131 —134	132¾	131½
51,100£	Eastern and South African Teleg., Ltd., 5 % Mort. Deb. 1900 redeem. ann. drgs., Reg. Nos. 1 to 2,343	100	5 %	5 %	5%	100 —104	100 —104	...	...
69,200£	Do. do. do. to bearer, 2,344 to 5,500	100	5 %	5 %	5%	101 —104	101 —104	...	...
300,000£	Do. 4 % Mort. Debs. Nos. 1 to 3,000, red. 1909	100	4 %	4 %	4%	103 —106	103 —106	105¾	...
200,000£	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1 to 8,000	25	4 %	4 %	4%	108 —111%	108 —111 %	...	...
180,227	Globe Telegraph and Trust, Ltd.	10	4½%	4½%	4½%	11½— 12	11½— 12	11 13/16	11⅝
180,042	Do. do. 6 % Pref.	10	6 %	6 %	6%	17 — 17½	17½ — 17¾	17⅞	17 7/16
150,000	Great Northern Teleg. Company of Copenhagen	10	8¾%	10 %	10%	26 — 27	26 — 27	26½	...
160,000£	Do. do. do. 5 % Debs.	100	5 %	5 %	5%	102 —105	102 —105	...	...
17,000	Indo-European Teleg., Ltd.	25	10 %	10 %	10%	52 — 55	52 — 55	...	...
100,000£	London Platino-Brazilian Teleg., Ltd. 6 % Debs.	100	6 %	6 %	6%	107 —110	107 —110	...	...
28,000	Montevideo Telephone 6% Pref., Nos. 1 to 28,000... ...	5	4 %	4 %	...	2 — 2¼	2 — 2¼	...	...
484,597	National Teleph., Ltd., 1 to 484,597	5	5 %	5½%	5½%	6⅜ - 6⅝	6½ - 6⅝	6 9/16	6½
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	15 — 17	15 — 17	15 9/16	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	14 — 16	14 — 16	15 1/16	...
119,234	Do. 5 % Non-cum. 3rd Pref.. 1 to 119,234	5	5 %	5 %	5 %	6 — 6½	6 — 6½	6 1/16	...
130,765	Do. do. Nos. 119,235 to 250,000, £4 paid	5	...	...	...	4¾— 5¼	4¾— 5¼	...	...
1,329,471£	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	104 —109	104 —109	105⅞	105⅛
171,504	Oriental Teleph. & Elec., Ltd., Nos. 1 to 171,504, fully paid	1	4½%	5 %	5 %	9/16 — 11/16	9/16 — 11/16	...	...
100,000£	Pacific and European Tel., Ltd., 4 % Guar. Debs, 1 to 1,000	100	4 %	4 %	4 %	107 —110	107 —110	...	...
11,839	Reuter's Ltd.	8	nil	5 %	5 %	7 — 8	7 — 8	...	...
3,381	Submarine Cables Trust	Cert.	...	...	...	136 —141	136 —141	139	137
58,000	United River Plate Teleph., Ltd.	5	3 %	4 %	...	3⅜— 4¼	3⅜— 4¼	...	...
146,733£	Do. do. 5 % Debs.	Stock	5 %	5 %	...	102 —107	102 —107	...	...
15,609	West African Teleg., Ltd., 7,561 to 23,169	10	nil	4 %	nil	4½ - 5½	4½ - 5½	...	...
213,400£	Do. do. do. 5 % Debs.	100	5 %	5 %	5 %	103 —106	103 - 106	104	...
64,256	Western and Brazilian Teleg., Ltd.	15	3 %	3 %	2 %	9½ - 9¾	9½ - 9¾	9⅝	9½
33,129	Do. do. do. 5 % Pref. Ord. ...	7½	5 %	5 %	5 %	7½ - 8	7½ - 8	7⅝	7½
33,129	Do. do. do. Def. Ord.	7½	1 %	1 %	...	2¼ — 2⅜	2¼ — 2⅜	2 11/16	2⅜
382,230	Do. do. do. 4 % Deb. Stock Red. ...	Stock	...	...	...	106 —109	106 —109	106½	...
88,321	West India and Panama Teleg., Ltd.	10	¼%	¼%	1 %	⅜ — ⅝xd	⅜ — ⅝	...	...
34,563	Do. do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	8¼ — 8½xd	7⅞ — 8¼	8¼	7⅞
4,669	Do. do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	5 — 7 xd	5 — 7	...	...
80,000£	Do. do. 5 % Debs. No. 1 to 1,866 ...	100	5 %	5 %	5 %	107 —110	107 —110	...	
1,163,000$	Western Union of U. S. Teleg., 7 % 1st Mort. Bonds ...	$1000	7 %	7 %	7%	103 —107	103 —107	...	...
160,100£	Do. do. 6 % Ster. Bonds.	100	6 %	6 %	6%	100 —105xd	100 —105	...	...

ELECTRICITY SUPPLY COMPANIES.

30,000	Charing Cross and Strand Electy. Supply	5	4½%	5 %	6 %	12 — 13	12 — 13	12 13/16	12½
20,000	Do. do. do. do. 4½ % Cum. Pref.	5	...	...	...	6 — 6½	6 — 6½	6⅝	6½
26,000	*Chelsea Electricity Supply, Ltd., Ord., Nos. 1 to 10,277 ...	5	5 %	5 %	5 %	10¾— 10⅞	10¼— 10⅞	10⅝	10⅜
60,000	Do. do. do. 4½ % Deb. Stock Red. ...	Stock	...	4½%	4½%	112 —115	113 —116	114½	...
40,000	City of London Elec.Lightg. Co., Ltd., Ord. 40,001—80,000	10	5 %	5 %	7 %	27 — 28	27 — 28	27⅝	27⅛
10,000	Do. do. Prov. Certs.	5	...	...	...	26½— 27½	26½— 27½	27½	26⅝
40,000	Do. do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	17 — 18	17 — 18	17½	...
400,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	5 %	5 %	131 —136	131 —136	133	...
22,475	County of Lond. & Brush Prov. E. Ltg. Ltd., Ord. 1—22,475	10	...	nil	nil	13½ 14	13⅜— 14½	14⅜	13⅜
20,000	Do. do. do. 6% Pref., 40,001— 60,000 ...	10	...	6 %	6 %	15½— 15⅝	15½— 15⅝	15⅝	15 5/16
10,000	House-to-House Elec. Light Supply, Ord., 101 to 10,100	5	...	...		9½ — 9⅝	9½ — 9⅝	9⅝	9⅜
10,000	Do. do. 7 % Cum. Pref. ...	5	...	...		11 — 11½	11 — 11½	11⅜	...
49,900	*Metropolitan Electric Supply, Ltd., 101 to 50,000 ...	10	3 %	4 %	5 %	18 — 19	18¾ - 19¼	19⅛	18⅜
12,500	Do. Ord., 50,001—62,500, iss. at £2 prem. ...	10	...	...	...	17½ - 18½	18 — 19	18⅝	18 5/16
220,000£	Do. 4½% first mortgage debenture stock	...	4½%	4½%	4½%	119 — 123	119 —123	...	...
6,452	Notting Hill Electric Lightg. Co., Ltd.	10	1 %	2 %	4 %	15½ — 16½	16½ — 17½	16⅞	16¼
19,980	*St. James's & Pall Mall Elec. Light Co., Ltd., Ord., 101-20,080	5	6½%	7½%	10½%	16½ — 17½	16½ — 17½	17½	17
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	10 — 11	10 — 11	10 5/16	10¼
50,000	Do. do. 4 % Deb. stock Red. ...	Stock	...	...	...	103 —106	103 —106	...	...
43,341	South London Electricity Supply, Ord., £2 paid	5	...	...	...	2 — 2¼	2⅜— 2⅝	2⅜	2¼
67,900	Westminster Electric Supply Corp., Ord., 101 to 68,000 ...	5	5 %	7 %	9 %	14½ — 15½	15 — 16	15½	14 15/16

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.

‡ Unless otherwise stated all shares are fully paid. ‖ Dividends paid in deferred share warrants, profits being used as capital.

§ Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL, COMPANIES.

Present Issue.	NAME.	Stock or Share ‡	Dividends for the last three years. 1894.	1895.	1896.	Closing Quotation, Nov. 17th.	Closing Quotation Nov. 24th.	Business done during week ended Nov. 24th, 1897. Highest	Lowest.
20,000	British Electric Traction	10	...	...	...	12⅜ — 13¼	12⅜ — 13¼	12⅞	...
90,000	Brush Elect. Engng. Co., Ord., 1 to 90,000...	5	2½%	...	...	1⅛ — 1⅜	1⅛ — 1⅜	1⅛	1⅛
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	3 %	...	...	1⅞ — 2⅛	2⅛ — 2⅜	2¼	2⅛
125,000	Do. do. 4½ % Perp. Deb. Stock.	Stock	4½%	...	...	107 — 111	107 — 111	...	...
76,770	Do. do. 4½% 2nd Deb. Stock Red. ...	Stock	...	...	...	98 — 102	98 — 102	99	...
13,126	Central London Railway, Ord. Shares	10	...	...	...	9⅜ — 10¼	9⅜ — 10¼	9⅞	...
143 10	Do. do. do. £6 paid	10	...	...	...	5½ — 6	5½ — 6	...	...
58,830	Do. do. Pref. half-shares £1 pd. ...	...	...	...	...	1 — 1½	1 — 1½	...	...
61,777	Do. do. Def. do. £5 pd. ...	...	...	...	...	3⅜ — 4½	4 — 4½	4½	4
630,000	City and South London Railway	Stock	1½%	1 5/16%	1 9/16%	69 — 71	69 — 71	70½	69½
28,180	Crompton & Co., Ltd., 7 % Cum. Pref. Shares, 1 to 28,180	5	*nil*	*nil*	...	1½ — 2	1⅝ — 2¼	...	...
89,261	Edison & Swan United Elec. Lgt., Ltd., "A" shrs, £3 pd. 1 to 89,261	5	5 %	5 %	5½%	2¼ — 2⅝	2¼ — 2⅝	2½	2⅝
17,139	Do. do. do. "A" Shares 01—017,139	5	5 %	5 %	5½%	4 — 5	4 — 5	...	...
110,000	Electric Construction, Ltd., 1 to 110,000	2	*nil*	5 %	6 %	2 — 2¼	2⅜ — 2⅝	2 11/16	2¼
16,343	Do. do. 7 % Cum. Pref., 1 to 16,343 ...	2	7 %	7 %	7 %	3⅛ — 3⅜	3⅛ — 3⅜	3 3/16	...
91,195	Elmore's Patent Cop. Deposg., Ltd., 1 to 70,000	2	*nil*	...	...	⅜ — ½	⅜ — ½	...	...
67,275	Elmore's Wire Mfg., Ltd., 1 to 69,385, issued at 1 pm. ...	2	*nil*	...	...	⅜ — ½	⅜ — ½	...	...
9,600	Greenwood & Batley, Ltd., 7 % Cum. Pref., 1 to 9,600 ...	10	*nil*	10½%	...	9 — 11	9 — 11	...	...
12,500	Henley's (W. T.) Telegraph Works, Ltd., Ord.	10	6 %	8 %	10 %	20 — 21	20 — 21	20½	...
3,000	Do. do. do. 7% Pref.	10	7 %	7 %	7 %	18½ — 19½	18½ — 19½	...	...
50,000	Do. do. do. 4½ Mort. Deb. Stock	Stock	...	4½%	4½%	110 —115	110 — 115	...	...
50,000	India-Rubber, Gutta Percha and Teleg. Works, Ltd. ...	10	10 %	10 %	10 %	21½ — 22½	22 — 23	22½	22
300,000	Do. do. do. 4 % 1st Mort. Debs.	100	...	...	...	103 —107	103 —107	...	...
37,500	Liverpool Overhead Railway, Ord.	10	1½%	2⅞%	2⅞%	11 9/16 — 11 11/16	11½ — 11⅝	...	...
10,000	Do. do. Pref., £10 paid	10	5 %	5 %	5 %	16 — 16½	16 — 16½	...	...
37,25	Telegraph Constn. and Maintce., Ltd.	12	20 %	15 %	15 %	36 — 39	36 — 39	37½	37
15,000	Do. do. do. 5 % Bonds, red. 1899	100	5 %	5 %	5 %	102 —105	102 —105	...	...
54,000	Waterloo and City Railway, Nos. 1 to 54,000	10	...	...	...	12½ — 13	12½ — 13	12⅝	...

Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. ¶ Last dividend paid was 50% for 1890.
Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.
Crompton & Co.—The dividends paid on the ordinary shares (which have not a Stock Exchange quotation), are as follows: 1892—0%; 1891—7⅜; 1890—8%.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

* Birmingham Electric Supply Company, Ordinary of £5 (£4 paid), 7⅞, £5 (fully paid) 9½.

Electric Construction Corporation, 6 % Debentures, 103 – 106.

House-to-House Company, 4½% Debentures of £100, 107 – 110.

Kensington and Knightsbridge Electric Lighting Company, Limited Ordinary Shares £5 (fully paid) 14½—15½; 1st Preference Cumulative 6 %, £5 (fully paid), 8—8½. Dividend, 1896, on Ordinary Shares 7 %.

London Electric Supply Corporation, £5 Ordinary, 2½ – 2⅝.

Yorkshire House-to-House Electricity Company, £5 Ordinary Shares fully paid, 8—8½. Dividend for 1896—6 %.

* From Birmingham Share List.

Bank rate of discount 3 per cent. (October 14th, 1897).

THE DEVELOPMENT OF ELECTRIC CABLEWAYS.*

By RICHARD LAMB.

(*Concluded from page* 715.)

Insulated trolley hangers were secured, that showed an insulation resistance measured under 150 lbs. vertical stress above 300,000 megohms, and after sprinkling with water one half hour, measuring immediately above 300,000 megohms. After again sprinkling with water 20 minutes they measured immediately above 300,000 megohms.

Tested for absorption after soaking in water four days showed weight of 312·9 grammes; weight as received 312·7 grammes; absorbed 000·2 gramme.

In the insulated stud made for the saddles, the breaking strain measured over 35,000 lbs. At that point the insulation showed no signs of giving way, and the same stud was subsequently used for regular work. The instrument used for measuring the crushing strain measures only 50,000 lbs. It was thought best not to test above 35,000 lbs., which was more than needed in any service it would be required to perform. The pressure was put upon the top of the saddle and the bottom of the stud. As the thickness of the insulation is over twice as great on these saddle pins as was used on the trolley studs tested, the resistance should be at least over twice as great.

The best steel cables for cableways are the interlocked and patent locked wire rope. These are almost as compact as solid bars of steel, and yet can be easily coiled by hand in coils 4 feet in diameter. A simple coupling is used to connect the cables. The wheels of the car pass over these couplings so smoothly, that the rider on the motor scarcely notices the fact. These points of connection are as strong as any section of the cable. An advantage in these interlocked cables is, that they present a smooth surface of comparatively flat steel, which wears a great many times longer than the ordinary cables whose surfaces present round wires that wear through and unravel. These cables are made to bear much greater strains than the ordinary cables, and being so nearly solid, they make much better electrical conductors.

The traction cable is made of ⅝-inch or ¾-inch specially strong "19 wire" steel rope, with a soft iron wire core in place of hemp, which is ordinarily used. This increases the conductivity. One of the most remarkable results in practice in this system is the fact that the traction cable does not have to be pulled very taut; in fact, a sag in the cable seems to be of no disadvantage, as the motor does not tighten the line far ahead, even when doing considerable service. The sag adds to the weight of the cable and to the friction on the brackets, and these two resistances act as an anchor for the traction cable, independent of the terminal anchorages. For example, in the case of a trial plant for a German canal, the resistance to be overcome by a motor, or its "draw-bar pull," was to be 645 lbs. Now, at 1 lb. per running foot of traction cable, the influence of the motor pull would only be felt 645 feet ahead of the motor. Therefore with motors distributed 645 feet apart, each one practically has its traction cable anchored from the motor ahead, and in consequence the combined pull of all the motors is not exerted upon the terminal anchorage.

In the first plant, the clamps on each of the lower or traction cable brackets were made with steel jaws, with springs under them, such as are used on grip pulleys. When the traction cable was pulled the clamps gripped the cable, and when the motor lifted the cable on passing the bracket, the

* A paper presented at the 119th meeting of the American Institute of Electrical Engineers, New York, October 27th, 1897.

jaws released the cable. These clamps were found to be unnecessary.

In canal practice, the terminals will be 10 miles apart, with tension stations every two miles. At the terminal stations rotary transformers will transform the high voltage alternating current to 500-volt direct current, and send the same each way a distance of five miles. Where the traffic justifies, a line will be placed on each side of the canal, when the insulated or bearing cables will be connected at intervals to feed each other. The anchorage of the traction cable will be made with a series of clamps, and the motors will be passed through them as canal boats through locks. At the end the motor is released from its traction cable, and is conveyed across the canal on a cable, or where masts are allowed on boats in the canal, by a hinged trussed track that can be opened like a gate, or raised out of the way. The handle of the rheostat is easily controlled from the boat by a cord attached to the handle. When the cord is pulled from the opposite direction to which the motor is to be run, the current is admitted in the proper direction, and the motor proceeds. When the cord is released, the handle flies back to a vertical or cut-off position, and the motor stops. When two boats pass they exchange motors by simply exchanging tow-lines and controller cords.

The first test of canal boat towing with this system was made on the Delaware and Raritan Canal at the Trenton Iron Works. The motor was made to go over concave and convex curves, and up and down grades while towing the boat.

In reference to the test of canal boat towing on the Erie Canal, at Tonawanda, it is not necessary to make any apologies for the system. Superintendent of Public Works, Aldridge, in his report to the Legislature, unqualifiedly endorsed the system, and stated: "Early in the season of 1895 application was made to me to officially designate a part of the Erie Canal for the proposed test of the efficiency, economy and practicability of the so-called 'Lamb System' for improving the present system of towage on the canals of the State. The location selected was a piece of canal about 1¼ miles in length, at Tonawanda, N.Y. The purpose was to select such a portion of canal as would embrace as many practical obstacles to the success of such a plan of towing as could be found anywhere in a section of canal that length."

In the report of Chas. R. Barnes, electrical expert for the Public Works Department of the State of New York, he sums up by saying: "The electric towing system appears to present so many meritorious features that I have no hesitation in endorsing it as the system deserving preference over any other hitherto experimented upon, or likely to be devised in the near future."

So short a time was given in which to construct the trial plant, that existing models had to be copied. The motor was over 9 feet in length; it weighed 2,213 lbs. The elliptically grooved sheave was driven by a worm gear. The voltage, which was gotten from a trolley lime, fluctuated from nothing to 500 volts, but seldom equalled the latter amount. The bridges under which the motor had to go were very low, and had to be approached by reverse curves on a grade of about 20°. Trenches had to be dug next to the abutments to give room for the motor to pass under the bridges. Both convex and concave curves had to be passed over, and at one point the deflection was about 30°. In spite of the difficulties, the trial showed that the system performed economically and efficiently all that it was designed to accomplish.

In the plant recently constructed for trial on a German canal, the motor has been shortened to less than 5 feet in length; its weight reduced to 1,300 lbs. The worm gear has been avoided by a double reduction direct gear, gaining 50 per cent. in efficiency over the worm gear, and the elliptically grooved sheave has been placed about the cylindrical electric motor, getting a large bearing surface and increasing the efficiency accordingly. At the test made at the Trenton Iron Works this motor, using a 5 horse-power Storey motor, wound for 500 volts, and going at the rate of 2·3 miles per hour, pulled 800 lbs. when having the use of only 220 volts. This shows a remarkable efficiency, which is due to the mechanical principles utilised, viz., hauling the motor along by a fixed rope, attached to a capstan operated by practically a winch.

The uses to which this method of telpherage can be put are so numerous that I will not attempt to give descriptions of plans that have been, and are now, being made for various parties, for such services as fortification work, rice culture, mining plants, ship building, and sewer excavating plants. I will confine my descriptions to completed work.

Possibly the most universally serviceable application that has been made of the system is traversing motors with double hoisting drums for quarry purposes. These motors are to go on 700 feet span cableways. Each of these cableways has one end stationary, and the other is movable on a curved track. It is designed to lift 10,500-lb. rocks at the rate of 100 feet per minute, and traverse at the rate of 600 feet per minute. At a test at Trenton, made upon a temporarily erected cableway, we raised 6,600 lbs., and ran on the cable at the rate of 10 miles per hour, part of the time going up a grade of over 30°. There will be no difficulty in these motors raising over 10,500 lbs., and running 10 miles an hour. A 15 horse-power Storey motor is used. The rheostat reverses the motor, and regulates the speed. A band brake also is used to regulate the stopping. This is controlled by a lever in front of the motorman. There is a safety brake to be used in case the band brake should fail. This is operated by a wheel. The shoe of this brake clamps the upper cable. It is attached to the car proper, and with the wheel handle oscillates with the carriage as it climbs or descends grades. A lever in front of the motorman is used to control the speed of the drums that raise and lower the skip. A friction clutch, controlled by a wheel handle, disconnects the traversing sheave gear, and engages the hoisting drums, or *vice versâ*.

In a place within reasonable distance of an electric plant having surplus power, these electric cable hoists can be erected and operated for a comparatively small cost. In contracting work, where electric lights are also used, these cable cranes can be used to great advantage. In other places the small generating plant necessary to operate these motors will add but little to the expense of an outfit.

Those who think that electrical machinery is of such a delicate nature that it is only serviceable for cities of advanced civilisation, should go to the Dismal Swamp, and see a so-called dainty machine doing as rough and dirty work as any service to which a machine could be put. He would see the labourers, over their knees in mud, sawing down giant trees, and hear the woodman sing: "Stand from under, she's saying good-by to her neighbours." With a crash that throws mud and water high into the air, a tree will fall and fill a space with broken limbs, embedding itself well into the mire. This means work for the motor. Logs are to be drawn from their beds, and when the ammeter in the generator room on the scow for an instant runs up possibly to a point of overload, it is the motor overcoming the suction in drawing out a buried log. With the voltmeter standing at 220 volts, you would see the needle momentarily go to 35 amperes and then drop to about from 10 to 16, depending upon the size of the log. As the cone over the end of the log strikes a stump or a cypress knee, the needle flies to about 20 and then back, and as the log dives off of an obstruction it may be crossing, the current drops to zero momentarily. Finally, when the log reaches the tail-tree about 20 amperes is recorded as the log rises from the ground and hangs suspended by the hauling cable. This cable is rived through a sheave, which is attached to the tail-tree 50 or more feet from the ground.

After a number of logs are drawn to the tail-tree, they are transported over the cableway to the terminal on the banks of the canal. Reading the ammeter as the log comes in we see it start at about 5 then go up to 12 or 14, as it crosses the bracket saddles, then go down to 5 again. In this process of transportation, one end of the log is suspended by a car on the cable. The end of the log is raised from the ground by holding fast the bight of the grip-block rope and going ahead with the motor. The block is attached to the car, when the same results are produced, as if the power was applied to the rope direct. When the end of the log has been raised to the proper elevation, the grip holds it from falling, and the rope is coiled and placed on the tongs which holds the log, and after getting a couple of cars loaded you are ready to carry your valuable logs from one of nature's worst fastnesses to a point where they become valuable to mankind.

The question has been asked, "Do you require expert help about these logging plants?" In answer, I would say that

I am satisfied with my superintendent. He has spent his life in swamp logging, and has had no chance for education, much less scientific studies. When I assembled the generator, the first time that I put up the plant, he put on a pair of rubber gloves, not wishing to run any chances of getting a shock, even if there was no fire in the boiler. While testing the plant a fuse blew out on the generator, and one of my negro helps started on a run in the swamp and never returned again to work. I afterwards heard that he stated: "Mr. Lamb can't fool dis nigger, I done worked on the Government dredge boat, and knows what a dynamite machine is."

In spite of the lack of electrical information of the logging crew, no inconvenience has been occasioned on that account. All features of insulation are provided for before the plants are shipped. An ordinary steam engineer acquires quickly the necessary information for running the dynamo. The motor is shipped with all parts adjusted, and the extent of the motorman's duties is simply to push the handle of the rheostat according to the direction he wishes to go.

The light first cost, the high efficiency, the ease with which it can be operated by ordinary mechanics, portend for this system an important place among the useful applications of electricity of this century.

THE DISTRIBUTION OF ELECTRICAL ENERGY.*

By C. H. Wordingham, A.M.I.C.E., M.I.M.E, M.I.E.E.,
City Electrical Engineer, Manchester.

(*Concluded from page* 736.)

A great advantage of these mains is their security. The conductors being rigidly fixed at a good distance from one another, and the insulation being absolutely incombustible, there is far less danger of a short circuit than with any continuously insulated system.

The durability of these mains promises to very greatly exceed that of every other kind. After 2¼ years' experience of this, and over 4 years' experience of another system of bare copper distributors, also described in the appendix, which, although very good, is inferior to the stretched system in several respects, the author is able to state that not a yard of either kind has had to be renewed, nor is there any sign of deterioration.

The ease and cheapness with which service connections can be made is a great recommendation. In the original Crompton system all such connections were made at an insulator, to which access was obtained by means of a box lid. In the author's practice these insulators are flagged over, and connection made at any point, even midway between two insulators. This is done quite safely by fixing the service conductors in the wall of the culvert. They then actually assist in keeping the main conductors rigid. A porcelain insulator is placed beneath a service cable where it crosses the bare strip to prevent accidental contact. It will be noticed that, contrary to all continuously insulated systems, the T-joint does not lower the insulation resistance of the mains to any appreciable extent.

The cost of the system does not differ greatly from any other good class of mains, but even if its first cost were much higher, the author would prefer it on account of its durability and safety. The relative cost diminishes rapidly as the size of the conductors increase.

Without insisting greatly on the point, it may be mentioned that it is quite easy to draw in additional copper at any time, but to do this all the T-joints must be unclamped, and the supply cut off from the main.

The supposed drawbacks to the system are danger of flooding and liability to explosion of gas. As regards the former, it is difficult to see how the water could get in, but, even if it did, it is unlikely it would reach the copper, as the culverts have all a fall of at least 1 in 100, and are connected to boxes at each end, all of which are drained to the sewers. Further than this, even if the copper were immersed, supposing the water to be pure, it is quite likely that it would be found feasible to continue running on the main until the culvert could be emptied. With respect to explosion, it is of course possible that gas might find its way into the culvert, but with good ventilation, such as is recommended in another part of this paper, the danger is small, and the author has never had an instance, though he has had several explosions where insulated cables have been run in pipes, and that without the presence of coal gas.

The author begs the indulgence of the members of the society if he be somewhat of an enthusiast in respect to bare copper; he would plead in extenuation that his enthusiasm is based upon experience, while he has observed that the strongest opponents of the system are those who have never laid or used a yard of this class of main. In Manchester there is 1 mile 308 yards of distributor laid on the slotted insulator system which have been at work for over four years, and there are four miles 1,690 yards, or just five miles of distributor on the stretched system which have been at work for varying periods up to 2¼ years. Both classes are in perfect order, and show no signs of deterioration. In one instance there was a short-circuit with the slotted insulator system owing to the wedges becoming loose, and allowing the copper to buckle, and there was one short-circuit on the Crompton system on the first length laid due to the carelessness and inexperience of a workman causing two strips to be forced together. With these two exceptions, there has been no trouble of any kind with either system of distributors.

The one disadvantage of bare copper is its want of flexibility; there must be a clear way of considerable cross-section for it, and in certain positions it is therefore impossible to employ it; it is not advisable either to lay bare copper in wide roadways subject to heavy traffic.

When bare copper cannot be used, the author considers the next best system is a number of continuously insulated cables laid side by side, supported and separated by wooden bridges, and completely surrounded by Trinidad bitumen, held in cast-iron or wooden troughs. This system was introduced some 10 or 12 years ago by Mr. Callender, and has given excellent results; the system as used in Manchester is fully described in the appendix. The insulation the author pefers is vulcanised bitumen, as it is much cheaper than rubber, is probably more durable, is very light for laying, and is easily jointed. Its insulation resistance, while considerably lower than rubber, is amply high enough. The tests which the cables used have to pass are given in the appendix.

Here it may be well to correct a very widespread illusion. It is commonly supposed that the core of vulcanised bitumen cables readily decentralises. This is not the case. The material is tough, and the melting point very high; on three occasions the author has had short-circuits on these cables, once from a pick being driven through them, and twice from bad joints, and on each occasion he was much struck with the small distance to which the damage had extended, the covering being intact, and not melted, quite close to the molten copper.

Joints on these cables are made very expeditiously, and it will be observed that the system admits of the mains being tapped at any point (for method of jointing see appendix).

The following figures will serve as a guide to the results attained as regards insulation resistance.

Table B.—Vulcanised Bitumen Cables laid on Callender's Solid System.

Length of conductors.	Size of conductor.	Insulation resistance.		Date of test.	Weather at time of test.
		Of length.	Per mile.		
Yds.	Sq. in.	Megohms.	Megohms.		
58	⅛	18,568	612	May 26, 1897.	Very damp.
	⅛	14,442	476		
	⅛	16,247	535		
	⅛	12,998	428		
	¼	14,442	476		
	¼	12,480	1,326		
187	¼	20,800	2,210	Nov. 4, 1896.	Very foggy.
	¼	20,800	2,210		
	¼	20,800	2,210		
	¼	15,600	1,657		
254	⅛	12,669	1,828·3	Jan. 19, 1897.	Very frosty.
	⅛	10,365·5	1,495·9		
	⅛	5,701	822·7		
	⅛	10,365·5	1,495·9		
	⅛	12,669	1,828·3		
252	⅛	6,003	859	Feb. 15, 1897.	Damp.
	⅛	6,003	859		
	¼	85	12·1		
	¼	2,641	378·1		
	¼	4,002	573		
85	⅛	14,642	707·1	Mar. 30, 1897.	Fine.
	⅛	14,642	707·1		
	⅛	12,812	618·7		
	¼	17,083	825		
	¼	17,083	825		
237	⅛	10,100	1,360	Feb. 5, 1897.	Drizzling rain.
	⅛	10,100	1,360		
	⅛	8,912	1,200		
	⅛	15,150	2,040		
	⅛	8,912	1,200		
18	¼	19,505	199	Feb. 1, 1897.	Very damp.
	¼	19,505	199		
	¼	27,307	279		
	¼	22,756	232		
	¼	22,756	232		
75	⅛	33,726	1,437	April 12, 1897.	Very damp.
	⅛	25,294·5	1,077·8		
	⅛	33,726	1,437		

Note.—The insulation resistance was tested with the same apparatus as was the copper strip.

The author has only used these cables for slightly over a year, but they appear highly promising, and with the exception of the short circuit above mentioned, none of which can be ascribed to the cables themselves, they have given no trouble whatever. The quantity now laid as distributing mains in Manchester is as follows:—

* Read before the Northern Society of Electrical Engineers, November 8th.

	$\frac{1}{16}$ sq. in.	$\frac{1}{8}$ sq. in.	$\frac{1}{4}$ sq. in.	$\frac{1}{2}$ sq. in.
Length of single conductor laid	2 miles.	8 miles.	14 miles.	3 miles.

The author has laid a fair amount of vulcanised india-rubber covered cables on this system, chiefly cable which had been withdrawn from pipes, and which had had old T-connections cut off, and the places made good; he would not have dared to use these cables over again, except in this way. The results so far have been very satisfactory.

The main point of the so-called "solid system" is the exclusion from the cables of moisture, and of everything that can harm them. The Trinidad bitumen used for this purpose is waterproof, and it is known that it remains unchanged for centuries. In laying rubber cables in this manner, it is important to remember that the bitumen must not be used hotter than is absolutely necessary to enable it to flow, otherwise the rubber will be over-vulcanised.

It may not be out of place here to say a few words as to vulcanised india-rubber. There are laid in Manchester some 80 miles of single conductor in which this material is exclusively used, 15 miles of which has been at work for over four years, so that the author has had some experience of it. There have undoubtedly been a fair number of instances in which it has failed, but in all these cases the damage has been local—that is to say, there is no evidence of a general deterioration of the cable; it has merely failed at one particular point, and the failure appeared to be due not to the rubber, but to the way in which it is laid. The author has before expressed himself as averse to drawing-in systems. These cables are drawn into pipes. In many cases they were drawn in one after the other, though for some considerable time the author has made a practice of drawing all five in together. It is impossible to ensure that the interior of a pipe shall be absolutely smooth, and if there be a slight obstruction, the men drawing in cannot feel the extra pull on the cables, and great damage may be unconsciously done. A pipe laid underground cannot be kept perfectly dry, and water will occasionally find its way in, the cables being thus alternately wet and dry, which is very destructive. Mechanical damage may readily arise from the rope used to draw in other cables, and rats may enter the pipe and gnaw the cables. In one instance the author found a considerable quantity of nibbled rubber in a pipe, the rat having apparently gnawed it because it was an obstruction, and not for gastronomic reasons. The most fruitful source of danger, however, has been observed by the author to be caused by cement. Wherever a vulcanised rubber cable is in contact with Portland cement and moisture, it will almost certainly fail. The author has had a good many cases in which a rubber cable passing through a glazed earthenware pipe, fixed into the side of a brick box with cement, has been attacked just at the mouth of the pipe. Large masses of salt have formed, and in several cases a considerable quantity of metallic sodium has been found.

In main laying, great care should be paid to details. Thus the cables should all be laid on a definite plan, cables of the same polarity should always be to the right when looking down the main with the back to the station, and when this rule cannot be applied, the same pole should always be next the buildings. If a drawing in system be employed, the cables should be differently coloured throughout their length, or two may be of one colour, one being braided, the other taped. Again, the ends of all the cables of the same polarity should be painted the same colour, a different colour being selected for each pole. Among other details, one of great importance is the treatment of the ends. The author has found the best way to avoid surface leakage is to pare down the insulation for three or four inches, and the braiding or lead for a couple more; pure rubber strip is then tightly lapped round from the conductor to a point two or three inches over the braiding, *i.e.*, for a length of eight or nine inches, this rubber is then painted over with anti-sulphuric enamel of appropriate colour. Immediately a cable is laid, the ends should be sealed until it can be treated as above, for if water be admitted to the interior, it may do great damage, even if the dielectric be waterproof.

Intimately associated with mains are junction boxes. These should always be well ventilated and the lids left loose. The former course will tend to prevent an explosion, and the latter to diminish its destructiveness if it occurred. It is very difficult to make a lid watertight, and apart from this, a packed lid takes time to open in case of emergency; in the author's judgment it is best not to attempt the exclusion of water, but to let it get in and drain it away. A ventilated cover, as devised by the author, in use in Manchester, will be found described in the appendix. Junction boxes should always be drained except in very sandy soils, and plenty of room should be allowed in them. It is a great mistake to endeavour to make them small, the extra space costs little either for excavation or building, and the advantage in point of convenience and safety is great.

Balancing sub-stations naturally call for attention when speaking of junction boxes. They are most conveniently constructed under the footpath. They should be well lighted, and means should be provided for readily bringing in plant, and removing portions for repair. It is essential that they should be absolutely fireproof, and it is advisable to maintain a slight pressure of air within them in order to obviate any risk of the entrance of coal gas, or of noxious vapours from the sewers or soil. The construction adopted in Manchester will be found fully described in the appendix.

The following is a summary of the distributing mains laid in Manchester up to the present time.

The size of main is reckoned by one of the outer conductors, hence the lengths given are the actual main and not single conductor, some of the mains being 5-wire ones, others 3-wire, and a few 2-wire, as will be seen from the particulars:—

Length of Distributing Mains Laid in Manchester.

5-Wire.				4-Wire.				3-Wire.				2-Wire.
$\frac{1}{2}$ sq. in.	$\frac{1}{4}$ sq. in.	$\frac{1}{8}$ sq. in.	$\frac{1}{16}$ sq. in.	$\frac{1}{2}$ sq. in.	$\frac{1}{4}$ sq. in.	$\frac{1}{8}$ sq. in.	$\frac{1}{16}$ sq. in.	$\frac{1}{4}$ sq. in.	$\frac{1}{4}$ sq. in.	$\frac{1}{8}$ sq. in.	$\frac{1}{16}$ sq. in.	$\frac{1}{8}$ sq. in.
Yards.	Yards.	Yards.	Yards.	Yards.	Yards.	Yards.	Yards.	Yards.	Yards.	Yards.	Yards.	Yards.
17,461	16,555	8,103	180	...	128	285	70	897	4,314	4,978	820	2,354

Total length of distributors, 31 miles 1,585 yards.

The author believes that with the exception of a few cases, not more than half a dozen, all the failures of rubber cable which he has experienced are to be accounted for either by the presence of cement, by a sharp edge or projection in the pipe, or by other mechanical damage.

In connection with rubber cables, it is interesting to note that vulcanised joints have been employed in Manchester in all cases, and in no one instance has such a joint failed.

It would be tedious to describe all the kinds of insulated cables made. Whatever may be the insulating material, the author would lay the cable on the solid system, so as to preserve it from attack.

Whatever the material, the specification should prescribe a definite insulation resistance depending on its nature, and in addition certain mechanical tests. The so-called "bending test," first introduced by the author in a specification of his in July, 1895, is a useful one. It consists in bending a sample piece of cable backwards and forwards several times round a drum of small diameter, then immersing the cable in water, and finally breaking it down under pressure. A certain ultimate dielectric strength should be settled on for each material. Stretching tests should also be included for such materials as rubber.

A form of built-in system, which has met with a great deal of favour, consists in enclosing the cable in steel armour, either in the form of stranded wire or of ribbon. This armour is then lightly braided over, and the cable laid directly in the ground. In spite of its having been largely adopted in many towns, the author cannot feel any confidence in the durability of this system. It appears certain that the steel must be attacked in the course of a few years, and the cable is then subject to the action of all kinds of soils. That this disadvantage is being recognised appears certain from the fact that it is becoming the practice to lay such cables in a wooden trough, and to run them round with pitch or some similar material, thus practically coming to the solid system advocated above.

With the exception of those laid at the initial stage of the undertaking, these mains have all been put down by the Corporation's own workmen, under the personal supervision of the author, and, in his opinion, this is by far the wisest course, as, not only is there a better chance of securing good work in this manner, but the men who have subsequently to maintain the mains are familiar with them, and know exactly where to look for weak points should trouble arise.

The author has purposely refrained from giving the cost of the various mains, partly because they are nearly all 5-wire ones, and the figures are therefore not applicable to other towns, partly because it would involve publishing contract prices, which is contrary to the practice of the Manchester Corporation.

The subject of mains may now be left, and attention drawn to service lines. It is necessary to have these very flexible, as they have frequently to be taken round corners, and often some little distance in a building. It is further desirable to be able to draw in additional cables in the event of subsequent extension by the consumer.

The author first tried rubber cables in wrought-iron pipes. The objections to this system are—

(1) Its extreme awkwardness if there are many bends.
(2) Liability to destruction of the pipe in certain soils.
(3) Dangers of cables being cut by the edge of the pipe.
(4) Establishment of connection between consumer's premises and main pipe or culvert, allowing bad smells to enter house.

In certain cases where no bends were required, cast-iron pipes were used, thus getting rid of the second objection. In both cases the cables are liable to be attacked by the cement at the end of the pipe.

The next system tried was rubber-covered cables, armoured with two steel ribbons, and drawn into a common earthenware pipe. This was a great improvement, as it allowed a much neater job to be made inside the premises, and obviated the second and third

objections to the first method. The armour was also some protection against the action of the cement.

Both these systems admit of additional cables being drawn in except when there are many bends.

The third system, and that now exclusively used by the author, is armoured rubber cables laid solid in bitumen in wooden troughs with cast-iron covers. This is described fully in the appendix. This system appears as near perfection as possible, the only drawback being that additional cables cannot be drawn in. This, however, merely necessitates the cutting of an additional hole in the wall, not a serious matter in comparison with the advantage of a system free from all the drawbacks named above.

The distributing system ends with the service cut-out and meter. These cannot be too simple, and, above all things, it is desirable to have uniformity.

The cut-outs used in Manchester will be found described in the appendix. They have proved very successful, are cheap, give very high insulation, and all classes of services can be dealt with only three patterns, all very similar.

With regard to meters, it is well to choose one pattern, and to keep to it. Nothing is so confusing or so wasteful of time as to have a number of different types, especially when an instrument has to be changed. By keeping to few types, it becomes possible to standardise everything, even to the boards for supporting cut-outs and meters. Samples of these are in the room.

In conclusion, the author cannot but feel that he has trespassed greatly on the time and patience of the members of the society. He has endeavoured to express his own individual opinion on several controversial subjects, and he trusts there will result an animated and instructive discussion which will to some extent atone for his tediousness.

MECHANICAL FEATURES OF ELECTRIC TRACTION.*

By PHILIP DAWSON.

(*Continued from page 744.*)

As the length of the car body grows greater, the difficulty increases of supporting it properly at the ends, without increasing the height of the car platform above the ground. The resistance offered by any truss to bending varies directly as the cube of its depth. If, therefore, the car platform were raised high enough above the street level, it would be an easy matter to support the sills of any car effectually so that it should be impossible for them to droop at the ends under heavy loads. It is an entirely different thing, however, so to support them, when the height from the rail to the lower edge of the sill is limited, as it must be in street tramways. Beyond 27 or at most 30 inches, every inch that the car platform is raised above the level of the street makes it so much the more difficult for ingress and egress. This is therefore practically the limit in height to which the car body used for city service can be raised. This problem has been solved by the use of extension rods, in a way never before applied in street tramways. A second bridge truss is constructed by employing the extension rod as a lower member and the car sill as an upper member; and this truss is supported flexibly upon the main truck truss. The truss extension rods instead of terminating as heretofore at the extremity of the truck frame, are carried below and around its lower member, and are stayed to the car sill by bolts passing through the truck pedestals and end springs. The angle of the truss extension rods has not been changed in any way to secure a longer support; but as they are dropped bodily lower, they give a wider base of support to the car body than would otherwise be possible. By this method it has been found practicable to carry upon single trucks, with a wheel base of only 7 feet, cars as long as 35 feet.

Other important improvements include the flexible gear, which is so constructed that it allows the cantilever extension truss to be built in sections: so that the portion under the journal boxes can be removed when necessary for taking out the wheels and axles, but when in place it makes a continuous truss. This gear also allows of introducing in its upper portion coil springs for supporting the truck frames flexibly upon the journal boxes, thereby relieving the truck frames as well as the car body from the rigid metal contact with the rail, and also relieving the rail from the hammer-blow which would attend a rigid connection between the rail and the car body.

Swivel Truck.—The rapid growth of inter-urban lines, upon which the tendency is to use long cars, and the desire on many tramways to use long cars for city work, have resulted in the swivel truck. This is the result not only of railway experience, but also of many years' experience of electric tramway needs. A truck so constructed runs exceedingly easy, the weight being doubly cushioned by the two elliptical springs and spiral springs over each axle-box. The brake gear is simple, and the shoes are applied with a powerful leverage. The centre of gravity of the trucks has been brought down as low as possible; with cars having straight sides, the body of the car need not be more than 27½ inches above the rail. The wheel base has been kept short, and the space between the axles kept clear, so that it is possible to mount two motors on the truck without difficulty. The arrangement of the springs on the trucks renders it possible to remove the bolster and elliptic springs quickly and easily, whenever it becomes necessary to examine and overhaul the motors. When this has to be done, the car body is simply jacked up with the bolster, and the truck frame can then be run out from under the car. The rivets used in the construction of all these trucks are driven in hot by means of pneumatic riveters under 30 tons pressure.

Motors.—In the early days the motors were all used with double-reduction gearing, with consequent great waste of power in a double transformation of the high armature speed to the low speed of the car axles, an efficiency of 60 per cent. being rarely obtained. At present, good design, workmanship, and materials have brought about such a change for the better that under most conditions an efficiency of 80 per cent is attained, which remains constant with widely varying loads. When the application of electricity for propelling street cars was first practically attempted, it was endeavoured to apply the existing stationary motor to the existing running gear. The motor and axle were connected by means of belts, sprocket chains, friction clutches, and other mechanical devices, all of which, with few exceptions, have now been abandoned, on account of the great expense of maintenance and their low efficiency. Double-reduction spur-gearing was first introduced on the experimental line at Woonsocket, Rhode Island, which was jointly equipped in 1886 by the Thomson-Houston and Bentley-Knight companies; and the advantages of a specially constructed and self-contained motor-truck were there demonstrated. The high speed and comparatively cumbersome construction of motors at that time necessitated a double reduction in gear between armature and axle, each reduction being about 9 to 1. Thus an armature speed of about 1,500 revolutions per minute gave a car speed of about 15 miles per hour. The later makes of double-reduction motors, of which a great many have been employed both in the United States and in Europe, have done excellent work; but more recent and keener competition in electric traction has resulted in more advanced designs being developed.

The electric motor having demonstrated its ability to do the required work, the next problem was so to improve it as to reduce the working expenses as low as possible. This was partially effected by improving the design of the double-reduction motor, and to a much greater extent by the introduction of single-reduction gearing. The success of single-reduction stimulated still further improvement in design; and motors mounted direct upon the driven axles, and devoid of all gearing, were developed. These, however, have not yet come into practical use for street cars, on account of their increased weight and also of their rapid deterioration owing to the absence of any spring support, in consequence of which the motors receive all the shocks due to the comparatively rough tramway lines. The increased weight and rapid deterioration, and consequent increase in original cost and maintenance, have prevented their competing on even terms with improved single-reduction motors.

Single-Reduction Motors.—The maturing of the design of single-reduction motors marks a distinct epoch in the construction of tramway motors. The practical experience of many years' use has proved them reliable and efficient; and they have fairly fulfilled the following essential requirements of a motor for tramways:—

1. The motor must be as light in weight as possible, having due regard to strength and simplicity in its mechanical and electrical construction.

2. It must be completely closed in, and protected from dirt, moisture, &c.

3. Its capacity must be ample, and it should be able to run continuously for at least two hours at its rated capacity, without heating beyond 90° to 135° Fahr. It should be capable of developing at least 50 per cent. more than its rated capacity without injurious sparking or other damage; and the starting torque must be great.

4. All the external and internal parts of the motor must be thoroughly accessible, and easily taken apart.

That motor is the best which enables the line to be worked at the lowest cost for fixed charges as well as for running expenses. The relation between weight of motor and expense of working is forcibly shown by the maintenance of way on various tramways at present working. A motor entirely protected from dirt, moisture, &c., needs far less repairs, and so diminishes the cost of working. If a motor does not keep within a certain limit of heating and sparking, renewals of parts will obviously become numerous and costly. Difficulty of access to the wearing parts means higher charges for maintenance and labour.

Gearing.—More than one reduction in gearing between armature and axle means too high speed of the armature, and consequently too great wear in the teeth. Any decrease in number of parts and bearings diminishes the cost of maintenance. Large teeth must be used, and the gearing must run in grease. Experience has proved the greater economy of steel over cast-iron gearing for tramway motors. A recent careful investigation of 66 tramways in 49 cities, using over 7,000 motors, has demonstrated that the average life of cast-iron gearing is somewhat over 30,000 miles, while that of steel gearing is nearly twice as great. Apart from the advantages of longer life and higher efficiency, there is much less danger of breakage in steel than in cast-iron gearing, and of consequent springing or breaking of shafts and frames. The teeth are cut out of a solid rim by finely made cutters of the best known shape, as determined by exhaustive experiments. Motor pinions should be made from the best hammered steel forgings, and the teeth should be formed by accurate cutters and specially designed machinery with the same care as is used in the manufacture of the gearing; and they should all undergo the same rigid inspection and tests as the gearing.

Power.—The average horse-power exerted by a tramway motor at the car wheel probably does not exceed 20 per cent. of the maximum power it is expected to exert in starting the car under the various conditions encountered. In order to get the best efficiency out of such a motor, it is necessary that its point of highest possible efficiency should coincide with the development of the power at which the greatest amount of work is to be done.

* Read before the Institution of Mechanical Engineers, November 4th.

Suspension of Motors.—There are three principal ways in which the motors can be suspended from the trucks; they are known as "nose" and "side-bar," and "centre" suspension. In the first method, one end of the motor rests on the axle through its bearings, while the other is hung from the truck by a cross-bar and springs. An advantage claimed for this method is that the gearing wears more evenly. In "side-bar" suspension the weight is nearly all taken off the axles. A side frame resting entirely on springs carries the motor by two lugs, one on either side, which are so placed that the motor is suspended from its centre of gravity. This plan has not proved as successful as was anticipated; and the first or "nose" suspension, is still much in use.

Rating of Motors.—This is rather a difficult question, because there are so many variable factors. At present nearly every manufacturer has a different method of rating, and a motor which would be called 15 horse-power by one is called 30 horse-power by another. A tramway motor works intermittently, and therefore can exert for brief periods a much larger power than it could continuously. Motors may be rated either by the torque which, when making a given number of revolutions per minute, they exert upon a wheel of a given diameter, that is to say, by their tractive effort; or else by the horse-power which they can develop. In both cases, however, care must be taken to state the length of time during which the motors are to exert their rated power; and also the rise of temperature permitted in that time. The General Electric Company, which is the largest manufacturing establishment in the United States, rates its motors by the torque which they can exert for one hour at the circumference either of a 30-inch or of a 33-inch wheel, at the speed for which they have been constructed, with a limiting rise in temperature of 135° F. after a run of one hour. Such a rating fairly represents the maximum conditions of ordinary working, and leaves sufficient margin to meet emergencies without injury to the motor. Instead of expressing the power of the motor by the torque, the tractive effort which the motor can give out at the normal speed may be stated. Motors may also be rated by the horse-power which they can safely give out temporarily, while they are so designed that they run continuously at half that rated power without their temperature rising by more than 90° to 135° F. Inasmuch as all the insulation used in the construction of tramway motors is practically fireproof, they can stand a far greater amount of heating than ordinary stationary motors. It is unnecessary to go into the electrical details of the devices used for controlling the speed with tramway motors; they can now be considered practically perfect, and they are so designed mechanically that it is impossible for an attendant to make a mistake in handling them.

Curves were exhibited showing the commercial efficiency, the torque at the circumference of a 33-inch wheel, and the speed, both with full and with shunted fields, of a G. E. 800 motor with a four-turn armature, that is, a General Electric motor having a torque of 800 lbs. This motor was originally constructed for American lines, and is designed for average speeds of 12 to 15 miles an hour. Another curve gave the efficiency, speed, and tractive effort of a G. E. 1,000 motor with full field, and one furnished by the kindness of the Westinghouse Company, gives the efficiency, the torque on a 30-inch wheel, and the horse-power developed, of a No. 46 motor, which is nominally rated at 25 H.P. The temperature tests of this machine were as follows:—Amperes, 38; electromotive force applied, 500; duration of test, one hour; draw-bar pull on 30-inch wheel, 1,000 lbs.; rise in temperature of commutator 54° F., of field, 115°, and of armature 72° F. For higher currents than the above the temperature will rise approximately as the square of the increase in current. But for lower currents the temperature will not fall according to the square of the decrease, because the element of iron loss is practically a constant, and is therefore of greater relative value at light loads.

Power Station.—The success or failure of an electric line depends to no small extent upon the situation and design of the power station. The conditions which govern its erection are in many ways entirely different from those which have to be considered in the construction of an electric lighting station. The load is constantly varying, and the variations are large and unexpected. Breakdowns are more serious than in electric lighting; and such precautions must be taken as will render a suspension of service practically impossible under any circumstances. In many instances the station must be in continuous operation for several consecutive days. In large American power stations certain of the engines have frequently been running for eight or ten days continuously. A diagram of the results obtained in a series of readings taken on an English tramway was given; and in Table 9 are given the sizes of engines recommended for use in power stations.

TABLE 9.

Sizes of Engines Recommended for use in Power Stations.

Maximum power required. I.H.P.	Number of engines.	Power of each engine. I.H.P.
200	2	200
400	3	200
600	3	300
1,000	3	500
1,500	4	500
2,000	4	750
5,000	6	1,000
10,000	6	2,000

In early days the engines employed were far too small and weak. At the present time dynamos for tramway work are so constructed that accidents to them are quite as rare as to the driving engines themselves. Countershafts have been abandoned as wasteful in power and useless. Large reserves of power were also provided on the earlier electric lines; this practice has been abandoned, and Table 9 shows the reserve power which should be allowed; it will be seen that a sufficient number of engines are provided to furnish the maximum horse-power required for working the line, with a surplus of one engine in reserve. With this reserve the machinery can be kept in perfect adjustment and repair, one engine being at all times stationary. In case of a breakdown, this extra engine is ready to take the place of the one disabled.

Driving.—A great diversity of opinion used to exist as to whether the engines should drive the generators by belts or ropes, or be directly coupled. The great objection advanced against direct coupling was the want of elasticity, which in the event of sudden and heavy overloading might cause a breakdown of the engine itself. It is said that belts and ropes act as a spring, and prevent sudden shocks from damaging the engine. It seems, however, to be beyond doubt that, for large stations having direct-coupled engines of 500 horse-power and upwards, slow-speed compound condensing engines, horizontal or vertical, are preferable. Direct-coupling is steadily gaining ground, and should always be used for units of 100 kilowatts and upwards.

Stations should always be built as compact as possible; but space, light, and above all, ventilation, should never be grudged in the engine room. Whether vertical or horizontal engines are adopted seems to depend primarily upon the available space; and secondly, and to a large degree, upon the fancy of the designing engineer.

Power.—Tramway work being of such a character that even in the largest stations the average load rarely exceeds two-thirds of the maximum, it becomes necessary, in order to have an economical engine, for it to be so constructed that at its most economical cut-off it will give out two-thirds of its maximum power. Thus, supposing an engine at its most economical cut-off of 28 per cent. will give 350 horse-power, at its maximum cut-off of 80 per cent. it will give 520 horse-power. When, therefore, an engine of 350 horse-power is ordered, it is expected to be able to run at 50 per cent. overload, the generators being constructed to stand the same strain. All bearings must be of such ample dimensions as to run perfectly cool when the engine is working at 50 per cent. above its rated power.

Engines.—In consequence of the difference of conditions between a lighting and a traction station, all engine builders who have had experience in tramway work now build an entirely different kind of engine for traction from that which they supply for lighting stations, as far as dimensions and weights are concerned, as indicated in Table 10. The conditions under which a tramway engine works are, if anything, more onerous than those of a rolling mill engine. A slight variation either in number of revolutions per minute or in angular velocity per revolution is of the greatest importance in a traction station, whereas it is of small importance in a rolling mill. A traction station should always be so arranged that, if the normal load be suddenly thrown on or off an engine, the speed shall not vary more than 2 per cent. In some cases a maximum variation of 1½ and 1¼ per cent. is all that is allowed. Where polyphase currents are used, constant speed is of even greater importance; and a guarantee should be required that under no circumstances shall the angular

Table 10.

Comparative Weights of Engines for Lighting and for Traction.

Power of engine.	Weight of engine.		
	For lighting.	For traction.	Difference.
I.H.P.	Lbs. Tons.	Lbs. Tons.	Lbs. Tons.
90	13,000 = 5·8	15,000 = 6·7	2,000 = 0·9
115	15,000 = 6·7	17,000 = 7·6	2,000 = 0·9
140	21,000 = 9·4	23,500 = 10·5	2,500 = 1·1
215	33,000 = 14·8	37,000 = 16·6	4,000 = 1·8
325	46,000 = 20·5	50,000 = 22·3	4,000 = 1·8
400	53,000 = 23·7	58,000 = 25·9	5,000 = 2·2
500	74,000 = 33·0	80,000 = 35·7	6,000 = 2·7

velocity during one revolution vary more than three-quarters of one per cent, and in some cases not more than half of one per cent. With heavy fly-wheels, and governors properly designed for tramway work, especially when the governors are of the fly-wheel kind, it is quite practicable to fulfil the above conditions. A shaft governor is undoubtedly far more satisfactory in every way than any ball governor driven by belt or gearing from the engine shaft.

Governing.—During the last few years there have been several fly-wheel accidents in tramway stations in America. Respecting these accidents and fly-wheels in general more is said later on. Most fly-wheel accidents have occurred with engines employing a releasing valve gear and a delicate ball-governor. When the load is suddenly thrown off, and when they have to work with no load and a vacuum, ball governors are too uncertain. They generally act; but occasionally the valve-gear, owing to wear or bad adjustment, prevents the engine from controlling itself. To obviate this, a second governor is put in engines of this class, which governs some ten revolutions slower than the main governor, and which, when it exceeds the speed it is set for, causes a stop-valve to trip, whereby the steam is entirely shut off from the engine. This seems to be an admission that such engines are liable to run away. With powerful shaft-governors connected directly to the cut-off valves by means of positive mechanism, it is impossible for engines to run away.

(To be continued.)

NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

NEW PATENTS.—1897.

[*Compiled expressly for this journal by* W. P. Thompson & Co., *Electrical Patent Agents*, 322, *High Holborn, London, W.C., to whom all inquiries should be addressed.*]

25,872. "Improvements in induction motors." F. M. Lewis. Dated November 8th.

25,883. "Improvements in apparatus for measuring a supply of electricity." W. A. Price. Dated November 8th.

25,889. "An improved cell or box suitable for accumulator or other electric batteries." F. C. Geary and J. H. Robottom. Dated November 8th.

25,890. "Improvements in or connected with electrolytic cells." G. Bell and G. W. Bell. Dated November 8th.

25,896. "Improvements in electrical switches." J. H. Tucker. Dated November 8th.

25,906. "Improvement in incandescent lamps or vacuum tubes for advertising." F. J. Jones and J. F. Stevenson. Dated November 8th.

25,970. "Improvements in the method or in connection with the means of operating electric railways." W. N. Stewart. Dated November 9th.

25,993. "Improvements in electric arc lamps." M. P. Gatte. Dated November 9th.

25,998. "Improvements in automatic circuit breakers." W. Fairweather. (The Crocker-Wheeler Electric Company, United States). Dated November 9th. (*Complete.*)

26,023. "Electrical instrument." C. A. Allison. (W. C. Banks, United States.) Dated November 9th. (*Complete.*)

26,026. "Improvements in the covers of domes of the switches of electrical glow lamps which improvements are also applicable to other electrical switches." R. G. Evered. Dated November 9th.

26,040. "Improvements in the construction of electrical transformers for use in three-wire system." The British Thomson-Houston Co., Ltd., and H. M. Hobart. Dated November 9th. (*Complete.*)

26,057. "Improvements in or connected with porous cells or receptacles for organic batteries." M. M. Bair. Dated November 9th.

26,067. "Improvements in electrolytical apparatus." F. E. Elmore. (Partly communicated by J. O. S. Elmore, India.) Dated November 9th.

26,089. "Improvement in terminal and connection screws and contact pieces for electrical purposes." D. G. FitzGerald. Dated November 9th.

26,097. "Improvements in or relating to galvanic batteries." R. J. Crowley, C. E. Monkhouse and A. J. Smith. Dated November 9th.

26,102. "An improved process for the production of pliable and elastic bodies by electrolysis." A. Kruger. Dated November 9th.

26,118. "A conduit and aerial electro-locomotor primarily for laying or drawing in electric mains or other cables for any service." E. L. Benjamin. Dated November 10th.

26,187. "Improvements in and in the manufacture of filaments for incandescent electric lamps." A. F. Woodley. Dated November 10th.

26,199. "Improvements in electric igniting devices for gas burners." H. H. Lake. (C. P. J. Clement and Hans von Krohn, Belgium.) Dated November 5th.

26,226. "Improvements in the mode of and means for clearing steel wire to receive an electro-plated coating." T. P. O. Yale. Dated November 11th.

26,244. "Improvements in the lighting of miners' safety lamps and the like by electricity." T. Ingham and H. Davis. Dated November 11th.

26,296. "Improvements in holders for incandescent electric lamps." A. Campbell. Dated November 11th.

26,306. "Improvements in switching gear for transformers, reactance coils, storage batteries and the like." The British Thomson-Houston Company, Limited, and H. M. Hobart. Dated November 11th. (*Complete.*)

26,332. "Improvements in and relating to the jointing of electrical cables." (Date applied for under Patents, &c., Act, 1883, sec. 103, May 11th, 1897, being date of application of France). H. E. Menier. Dated November 11th.

26,333. "Improvements in and relating to the transmission of telegraphic messages. J. A. L. Dearlove. Dated November 11th.

26,343. "Improved methods of and apparatus for manufacturing filaments of electric lamps." H. S. Maxim. Dated November 11th.

26,367. "Improvements connected with electrical illumination." H. Cooney. Dated November 12th.

26,373. "A pneumatic brush for dynamos, motors, or any machine for the production or use of electric current by rotary armatures." F. J. Taylor. Dated November 12th.

26,399. "Improvements in electrical measuring instruments." G. K. B. Elphinstone and A. C. Heap. Dated November 12th.

26,411. "Improvements in or relating to trolley standards and poles for electric cars." G. Henshaw. Dated November 12th.

26,412. "Improvements in electrical transformers." The British Thomson-Houston Co., Ltd, and H. M. Hobart. Dated November 12th. (*Complete*)

26,441. "Improvements in and preparations of accumulator plates." C. A. Bennett. Dated November 12th. (*Complete.*)

26,448. "An improvement in electric cables." G. Sutton. Dated November 12th.

26,455. "Method of and means or apparatus for detecting and indicating variations in the condition of circuits traversed by alternating currents applicable also for the measurement of the inductance resistance or capacity of electric apparatus for the transmission of orders and for other purposes." A. U. Alcock. Dated November 12th.

26,468. "An improved memorandum desk for use with telephones and for other purposes." C. Harryman. Dated November 13th.

26,476. "Improvements in or connected with electric lifts or raising or lowering apparatus." A. Musker. Dated November 13th.

26,496. "Improvements in watertight electric fittings." H. Davis and L. W. de Grave. Dated November 13th.

26,514. "Improvements in and relating to grids and supports forming part of accumulator plates." A. E. Greville. Dated November 13th. (*Complete.*)

26,530. "Improvements in apparatus for heating buildings and the like by means of hot fluids or electricity." J. A. Dargue, E. Griffiths and C. H. Wright. Dated November 13th.

26,543. "Improvements in apparatus for the generation and electrolytic application of electric currents." F. E. Elmore. (Partly by J. O. S. Elmore, India.) Dated November 13th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

[*Copies of any of these Specifications may be obtained of* Messrs. W. P. Thompson & Co., 322, High Holborn, W.C., *price, post free*, 8½*d.* (*in stamps*).]

1896.

14,157. "An improved form of washer for use in connecting secondary battery lugs and other electrical conductors." J. S. Highfield. Dated June 26th, 1896. Consists of a disc or washer with ridges on one or both faces, and is used for connecting together soft metals, such at secondary battery lugs, but may be used generally as an electric coupling. The drawings show such a washer with concentric V-shaped ridges on it with a central opening for a belt, also various methods of connection.

14,393. "Improvements in anodes for electrolytical purposes." P. Jensen. (H. C. F. Stormer, Norway.) Dated June 29th, 1896. Relates to electrodes for electrolysis, anodes are formed of carbon coated or covered with oil of platinum or other metal which is not acted upon by the electrolyte.

1897.

12,827. "Improvements in electric primary and secondary batteries." V. Jeanty. Dated May 24th, 1897. Relates to improvements in electric primary and secondary batteries. The main features of the battery is that its exciting liquid is, chemically speaking, kept separate from the depolarising liquid, although electrically, the electrodes are directly connected, while as regards the relative quantities of the liquids, contained in the cells, constant and uniform proportions are maintained. The negative electrode is formed of parallel wires secured to a cross bar serving as a collector, and the positive formed of laminæ of zinc secured to a transverse rod similar to the collector. The wires, rods or the like are placed at the bottoms of baths, such baths being of elongated shape, narrow and low, and communicating below, each at one end through and orifice with a feeding reservoir to which the said baths are properly filled. The baths and reservoir forming jointly a connecte whole are constructed of india-rubber. The negative collector is secured to the reservoir which has a false bottom situated a little distance below the upper edge of the baths. The whole arrangement is placed in a suitable reservoir. Acidulated water is distributed to the baths until the baths and the receiver are completely filled. Crystals of sulphate of copper placed upon the false bottom dissolve and form the depolarising liquid.